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Engineering electrical assessment
career but sustainability

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Engineering electrical assessment career but sustainability

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Send me a message

Thank You!

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| 11.5.Legal Frameworks for Public Safety |
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| 11.6..Ethics in Public Administration |
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| 11.7..Public Policy and Legal Implications |
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| 11.8..Human Rights and Social Justice |
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| 11.9.Crisis Management and Legal Compliance |

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| 4.1 .12.15..12.1Metallurgy in Oil and Gas Production, Refining, and Transport |
| |
| 12.2..Introduction to Metallurgy in Oil and Gas |
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| 12.3..Material Selection for Oil and Gas Production |
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12.4..Corrosion Mechanisms and Prevention

12.5..Metallurgical Processes in Refining

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| Discusses how metallurgical processes like heat treatment and welding are utilized in refining operations to enhance material properties.<br>Corrosion Mechanisms and Prevention |
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| 12.6..Pipeline Materials and Design |
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| 12.7.Advanced Coatings and Surface Treatments |
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| Advanced Coatings and Surface Treatments |
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| 12.8.Environmental Impact and Sustainability in Metallurgy |
| 12.9..Failure Analysis and Case Studies |
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| 12.10Future Trends in Metallurgy for Oil and Gas |
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| 4.1 .12.15..13.1.Integrated Water Management in Mining |
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| 13.2.Introduction to Mining Water Management |
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| 13.2.Water Resource Evaluation and Planning |
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| 13.3.Water Quality Management in Mining |
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| 13.4.Regulatory and Environmental Compliance |

13.5.Innovation and Technology in Water Management

13.6.Stakeholder Engagement and Social License

13.7..Climate Change Impacts on Water Resources

13.8.Case Studies and Best Practices

13.7.Future Trends in Mining Water Management

3.1 Integrated Water Management in Mining

13.2 Introduction to Mining Water Management

13.3 Water Resource Evaluation and Planning

13.4 Water Quality Management in Mining

13.5 Regulatory and Environmental Compliance

13.6 Innovation and Technology in Water Management

13.7 Stakeholder Engagement and Social License

13.8 Climate Change Impacts on Water Resources

13.9 Case Studies and Best Practices

13.10 Future Trends in Mining Water Management

.4.1 .12.15.14.Integrated Water Management in Mining

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| 14.1.Introduction to Mining Water Management |
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| 14.2.Water Resource Evaluation and Planning |
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| 14.3Water Quality Management in Mining |
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| 14.4.Regulatory and Environmental Compliance |
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| 14.5.Innovation and Technology in Water Management |

14.6..Stakeholder Engagement and Social License

14.7Climate Change Impacts on Water Resources

14.8..Case Studies and Best Practices

14..9..Future Trends in Mining Water Management

14 Integrated Water Management in Mining

14.1 Introduction to Mining Water Management

14.2 Water Resource Evaluation and Planning

14.3 Water Quality Management in Mining

14.4 Regulatory and Environmental Compliance

14.5 Innovation and Technology in Water Management

14.6 Stakeholder Engagement and Social License

14.7 Climate Change Impacts on Water Resources

14.8 Case Studies and Best Practices

14.9 Future Trends in Mining Water Management

4.1 .12.15..15.1.Advanced Manufacturing Techniques in Genetic Engineering

15.2.Introduction to Genetic Engineering

15.3..Manufacturing Processes in Biotechnology

15.4..CRISPR and Advanced Genetic Modification Techniques

15.5.Ethical and Regulatory Considerations

15.6.Biopharmaceutical Manufacturing

15.7.Fermentation Technology

15.8..Scale-Up and Commercialization

15.9.Quality Control in Genetically Engineered Products

15.10.Future Trends in Genetic Engineering Manufacturing

4.1 .12.15..15.1.Advanced Manufacturing Techniques in Genetic Engineering

15.2.Introduction to Genetic Engineering

15.3..Manufacturing Processes in Biotechnology

15.4..CRISPR and Advanced Genetic Modification Techniques

15.5.Ethical and Regulatory Considerations

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| 15.6.Biopharmaceutical Manufacturing |
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| 15.7.Fermentation Technology |
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| 15.8..Scale-Up and Commercialization |
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| 15.9.Quality Control in Genetically Engineered Products |
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| 15.10.Future Trends in Genetic Engineering Manufacturing |

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| 4.1 .12.15.16.1.Data Processing and Hosting Services in Computer Engineering |
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| 16.2.Introduction to Data Processing |
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| 16.3.Cloud Hosting Services |
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| 16.4..Big Data Technologies |
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| 16.5Data Security in Cloud Hosting |
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16.6.Containerization and Microservices

16.7Distributed Systems

16.8.Data Warehousing and Analytics

16.9..Serverless Computing

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| 4.1 .12.15..16.1 Data Processing and Hosting Services in Computer Engineering |
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| 16.2 Introduction to Data Processing |
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| 16.3 Cloud Hosting Services |
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16.4 Big Data Technologies

16.5 Data Security in Cloud Hosting

16.6 Containerization and Microservices

16.7 Distributed Systems

16.8 Data Warehousing and Analytics

16.9 Serverless Computing

4.1 .12.15..17.1.Masters in Cryptocurrency and Blockchain Applications

17.2.Introduction to Blockchain Technology

17.2.Cryptocurrencies: An Overview

17.3.Blockchain Consensus Mechanisms

17.4..Smart Contracts

17.5.Decentralized Finance (DeFi)

17.6.Blockchain in Supply Chain Management

17.7.Regulation and Compliance in Blockchain

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| 17.8.NFTs and Digital Assets |
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| 17.1 Masters in Cryptocurrency and Blockchain Applications |
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| 17.2 Introduction to Blockchain Technology |
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17.3 Cryptocurrencies: An Overview

17.4 Blockchain Consensus Mechanisms

17.5 Smart Contracts

17.6 Decentralized Finance (DeFi)

17.7 Blockchain in Supply Chain Management

17.8 Regulation and Compliance in Blockchain

17.9 NFTs and Digital Assets

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| 4.1 .12.15.18.1.Advanced Cybersecurity in Bibliotechnology |
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| 18.2.Introduction to Cybersecurity in Bibliotechnology |
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| 18.3Threats and Vulnerabilities in Digital Libraries |
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| 18.4.Data Privacy and Integrity in Bibliotechnology |
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| 18.5.Implementing Security Policies for Digital Libraries |
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| 18.6.Access Control in Library Networks |
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| 18.7.Digital Rights Management in Bibliotechnology |
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| 18.8.Network Security Essentials for Digital Libraries |
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| 18.9.Incident Response and Recovery for Digital Libraries |
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| 18..10Emerging Cybersecurity Technologies in Bibliotechnology |
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| 4.1 .12.15.18.1 Advanced Cybersecurity in Bibliotechnology |
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18.2 Introduction to Cybersecurity in Bibliotechnology

18.3 Threats and Vulnerabilities in Digital Libraries

18.4 Data Privacy and Integrity in Bibliotechnology

18.5 Implementing Security Policies for Digital Libraries

18.6 Access Control in Library Networks

18.7 Digital Rights Management in Bibliotechnology

18.8 Network Security Essentials for Digital Libraries

18.9 Incident Response and Recovery for Digital Libraries

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| 18.10 Emerging Cybersecurity Technologies in Bibliotechnology |
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| 4.1 .12.15..19.1.1Edge Computing in Modern Power and Energy Systems |
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| 19.2..Introduction to Edge Computing |
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| 19.3.Distributed Computing in Energy Systems |
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| 19.4.IoT Applications in Power Systems |
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| 19.5.Real-time Data Processing |
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| 19.6Security and Privacy in Edge Computing |
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| 19.6.Edge Analytics for Energy Management |
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19.7.Energy Efficiency Optimization

19.8.Case Studies on Edge Computing in Energy

19.9.Future Trends in Edge Computing for Energy Systems

19.1 Edge Computing in Modern Power and Energy Systems

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| 19.2 Introduction to Edge Computing |
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| 19.3 Distributed Computing in Energy Systems |
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| 19.4 IoT Applications in Power Systems |
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19.5 Real-time Data Processing

19.6 Security and Privacy in Edge Computing

19.7 Edge Analytics for Energy Management

19.8 Energy Efficiency Optimization

19.9 Case Studies on Edge Computing in Energy

19.10 Future Trends in Edge Computing for Energy Systems

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| Edge Computing for Modern Power and Energy Systems |
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| Introduction to Edge Computing |
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| Role of Edge Computing in Smart Grids |
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| Edge Computing for Renewable Energy Integration |
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| Data Management and Security in Edge Computing |

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| Machine Learning Applications on the Edge |
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| Case Studies in Edge Computing for Energy Systems |
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| Challenges and Future Trends |
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| 4.1 .12.15..20.1.Masters in Cyber-Physical Systems and Information Technology |
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| 20.2.Introduction to Cyber-Physical Systems |
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| 20.3.Architecture of CPS |
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| 20.4Networking and Communication in CPS |
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| 20.5.CPS Security and Privacy |
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| 20.6.Machine Learning in CPS |
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| 20.7.Real-Time Systems and CPS |
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| 20.8.Simulation and Modeling in CPS |

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| 20.9..Applications and Case Studies of CPS |
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| 20.1 Masters in Cyber-Physical Systems and Information Technology |
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| 20.2 Introduction to Cyber-Physical Systems |
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| 20.3 Architecture of CPS |
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| 20.4 Networking and Communication in CPS |
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| 20.5 CPS Security and Privacy |
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| 20.6 Machine Learning in CPS |
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20.7 Real-Time Systems and CPS

20.8 Simulation and Modeling in CPS

20.9 Applications and Case Studies of CPS

4.1 .12.15.21.1.Masters in Distributed-Ledger Technology Applications in Educational Technology

21.1. Introduction to Distributed Ledger Technology

21.2.The Need for Distributed Ledger Technology in Education

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| 21.3.Blockchain for Secure Credentialing |
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| 21.4.Smart Contracts in Educational Transactions |
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| 21.5..DLT-based Learning Management Systems |
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| Privacy and Data Security in DLT |
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| 21.6.Case Studies of DLT in Education |
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21.7.Future Trends in DLT and EdTech

21.1 Masters in Distributed-Ledger Technology Applications in Educational Technology

21.2 Introduction to Distributed Ledger Technology

21.3 The Need for Distributed Ledger Technology in Education

21.4 Blockchain for Secure Credentialing

21.5 Smart Contracts in Educational Transactions

21.6 DLT-based Learning Management Systems

21.7 Privacy and Data Security in DLT

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| 21.8 Case Studies of DLT in Education |
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| 21.9 Future Trends in DLT and EdTech |
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| 4.1 .12.15.22.1.Master's in Adult Education Services |
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| 22.1.Introduction to Adult Education |
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| 22.2.Theories of Adult Learning |
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| 22.3.Curriculum Design for Adult Learners |
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| 22.4.Assessment and Evaluation in Adult Education |
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| 22.5.Technology Integration in Adult Learning |
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| 22.6.Diversity and Inclusion in Adult Education |

22.7.Motivational Strategies for Adult Learners

22.8.Professional Development for Adult Educators

22.1 Master's in Adult Education Services

22.2 Introduction to Adult Education

22.3 Theories of Adult Learning

22.4 Curriculum Design for Adult Learners

22.5 Assessment and Evaluation in Adult Education

22.6 Technology Integration in Adult Learning

22.7 Diversity and Inclusion in Adult Education

22.8 Motivational Strategies for Adult Learners

22.9 Professional Development for Adult Educators

4.1 .12.15.23.1Quantum Computing in Systems Engineering

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| 23.1.Introduction to Quantum Computing |
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| 23.2.Quantum Algorithms |
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| 22.3.Quantum Gates and Circuits |
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| 22.4.Quantum Information Theory |
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| 22.5.Quantum Computing Platforms |
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| 22.6.Quantum Programming Languages |
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| 22.7.Applications of Quantum Computing in Systems Engineering |
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| 22.8.Challenges and Future of Quantum Computing |
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| 22.9.Quantum Supremacy and its Implications |
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| 23.1 Quantum Computing in Systems Engineering |

23.1 Introduction to Quantum Computing

23.2 Quantum Algorithms

23.3 Quantum Gates and Circuits

23.4 Quantum Information Theory

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| 23.5 Quantum Computing Platforms |
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| 23.6 Quantum Programming Languages |
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23.7 Applications of Quantum Computing in Systems Engineering

23.8 Challenges and Future of Quantum Computing

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| 23.9 Quantum Supremacy and its Implications |
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| 4.1 .12.15..23.2.Neurotechnology in Educational Technology |
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| 23.3.Introduction to Neurotechnology |
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| 23.4.Neuroscience Basics for Educators |
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23.5.Brain-Computer Interfaces in Education

23.6.Cognitive Load Theory and Neurotechnology

23.7.Neuroscience-Based Adaptive Learning Technologies

23.8.Ethical and Social Implications

23.9.Case Studies in Neurotechnology Education

23.10.Future Trends in Neurotechnology for Education

23.2 Neurotechnology in Educational Technology

23.3 Introduction to Neurotechnology

23.4 Neuroscience Basics for Educators

23.5 Brain-Computer Interfaces in Education

23.6 Cognitive Load Theory and Neurotechnology

23.7 Neuroscience-Based Adaptive Learning Technologies

23.8 Ethical and Social Implications

23.9 Case Studies in Neurotechnology Education

23.10 Future Trends in Neurotechnology for Education

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| 4.1 .12.15.24.1.Robotic Process Automation in Electrochemical Engineering |
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| 24.2Introduction to Robotic Process Automation |
| 24.3.Fundamentals of Electrochemical Engineering |
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| 24.4.RPA Tools and Platforms |
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24.5.Automating Electrochemical Process Controls

24.6.Data Collection and Analysis in Electrochemical Systems

24.7.Machine Learning and RPA in Electrochemical Engineering

24.8.RPA Implementation Challenges and Solutions

24.9.Case Studies and Industry Applications

4.1 Robotic Process Automation in Electrochemical Engineering

24.2 Introduction to Robotic Process Automation

24.3 Fundamentals of Electrochemical Engineering

24.4 RPA Tools and Platforms

24.5 Automating Electrochemical Process Controls

24.6 Data Collection and Analysis in Electrochemical Systems

24.7 Machine Learning and RPA in Electrochemical Engineering

24.8 RPA Implementation Challenges and Solutions

24.9 Case Studies and Industry Applications

4.1 .12.15.25.1.Integrating Educational Technology in Renewable Energy Studies

25.2.Introduction to Renewable Energy

25.3.Educational Technology Tools

25.4.Designing Interactive Learning Modules

25.5.Gamification in Renewable Energy Education

25.6.Virtual Labs and Simulations

25.7.Assessing Learner Outcomes in Technology-Driven Curriculum

25.8.Case Studies in Renewable Energy Education

25.9.Challenges in Integrating Technology and Renewable Energy Education

25.1 Integrating Educational Technology in Renewable Energy Studies

25.2 Introduction to Renewable Energy

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| 25.3 Educational Technology Tools |
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| 25.4 Designing Interactive Learning Modules |
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| 25.5 Gamification in Renewable Energy Education |
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25.6 Virtual Labs and Simulations

25.7 Assessing Learner Outcomes in Technology-Driven Curriculum

25.8 Case Studies in Renewable Energy Education

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| 25.9 Challenges in Integrating Technology and Renewable Energy Education |
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| 4.1 .12.15.26.1Wholesale Trade Management in Industrial Engineering |
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| 26.2.Introduction to Wholesale Trade |
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| 26.3.Supply Chain Dynamics |
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| 26.4.Inventory Control Methods |
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| 26.5.Logistics and Distribution |
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| 26.6.Procurement Strategies |
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| 26.7.Market Analysis and Forecasting |
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27.8.Risk Management in Wholesale Trade

27.9.Regulatory and Ethical Considerations

26.1 Wholesale Trade Management in Industrial Engineering

26.2 Introduction to Wholesale Trade

26.3 Supply Chain Dynamics

26.4 Inventory Control Methods

26.5 Logistics and Distribution

26.6 Procurement Strategies

26.7 Market Analysis and Forecasting

26.8 Risk Management in Wholesale Trade

26.9 Regulatory and Ethical Considerations

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| 4.1 .12.15..29. 1.Advanced Wireless Communications |
| |
| 29.2.Introduction to Wireless Communications |
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| 29.3.Radio Frequency Fundamentals |
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| 29.4.Wireless Signal Propagation |
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| 29.5.Multiple Access Techniques |
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| 29.6.Wireless Networking and Protocols |
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| 29.7.Cellular Systems and 5G |
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| 29.8..Antenna Theory and Design |
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| 29.8Wireless Security |
| 29.6IoT and Wireless Sensor Networks |
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| 29.1 Advanced Wireless Communications |

29.2 Introduction to Wireless Communications

29.3 Radio Frequency Fundamentals

29.4 Wireless Signal Propagation

29.5 Multiple Access Techniques

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| 29.6 Wireless Networking and Protocols |
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| 29.7 Cellular Systems and 5G |
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| 29.8 Antenna Theory and Design |
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| 29.9 Wireless Security |
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| 29.10 IoT and Wireless Sensor Networks |
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| 4.1 .12.15.30.1.Advanced Electrical Engineering in Construction and Civil Engineering |
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| 30.2. Fundamentals of Electrical Systems in Construction |
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| 30.3.Electrical Safety Standards and Codes |
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| 30.4.Integration of Electrical Systems in Building Design |
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| 30.5Sustainable and Renewable Energy Technologies |
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| 30.6.Smart Grids and Intelligent Networks |
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| 30.7.Electrical System Design and Simulation |

30.8.Power Quality and Energy Management

30.9.Electrical Systems in Infrastructure Projects

Advanced Electrical Engineering in Construction and Civil Engineering

30.2 Fundamentals of Electrical Systems in Construction

30.3 Electrical Safety Standards and Codes

30.4 Integration of Electrical Systems in Building Design

30.5 Sustainable and Renewable Energy Technologies

30.6 Smart Grids and Intelligent Networks

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| 30.7 Electrical System Design and Simulation |
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| 30.8 Power Quality and Energy Management |
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| 30.9 Electrical Systems in Infrastructure Projects |

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| 4.1 .12.15.Electrical Systems in Construction and Civil Engineering |
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| Introduction to Electrical Systems in Construction |
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| Power Distribution in Buildings |
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| Lighting Systems and Design |
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| Electrical Safety Standards and Regulations |
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| Sustainability in Electrical Engineering |
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| Smart Buildings and IoT Integration |
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| Electrical Load Analysis and Estimation |
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| Integration of Renewable Energy Sources |
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| Project Management in Electrical Engineering |
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| 4.1 .12.15.30.1.Doctorate in Specialist Engineering Infrastructure and Contractors: Electrical Engineering |
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| 30.2.Advanced Power System Analysis |
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| 30.3Renewable Energy Systems |

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| 30.4.Electrical Infrastructure Design and Management |
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| 31.5.Smart Grids and IoT Applications |
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| 31.6..High Voltage Engineering |
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| 31.7.Project Management in Electrical Engineering |
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| 31.8Energy Policy and Ethical Considerations |

31.1Sustainable Electrical Engineering Practices

30.1 Doctorate in Specialist Engineering Infrastructure and Contractors: Electrical Engineering

30.2 Advanced Power System Analysis

30.3 Renewable Energy Systems

30.4 Electrical Infrastructure Design and Management

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| 31.5 Smart Grids and IoT Applications |
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| 31.6 High Voltage Engineering |
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| 31.7 Project Management in Electrical Engineering |
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| 31.8 Energy Policy and Ethical Considerations |
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| 31.9 Sustainable Electrical Engineering Practices |
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| Admission Ready - Completing your application - Atlantic International University |

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| 32.Topic |
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| 4.1 .12.15..32.1Clean Energy Technology: Ecotechnology Applications |
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| 32.3.Introduction to Clean Energy and Ecotechnology |
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| 32.4.Solar Energy Technologies |
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| 32.5.Wind Energy Systems |
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| 32.6.Bioenergy and Biomass |

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| 32.7.Hydropower and Ocean Energy |
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| 32.8.Geothermal Energy |
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| 32.9.Energy Storage and Smart Grids |
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| 32.10.Policy and Economics of Clean Energy |
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| 32.11Ecological Impact of Renewable Energy |
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32.12.Future Directions in Clean Energy and Ecotechnology

2.1 Clean Energy Technology: Ecotechnology Applications

32.3 Introduction to Clean Energy and Ecotechnology

32.4 Solar Energy Technologies

32.5 Wind Energy Systems

32.6 Bioenergy and Biomass

32.7 Hydropower and Ocean Energy

32.8 Geothermal Energy

32.9 Energy Storage and Smart Grids

32.10 Policy and Economics of Clean Energy

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| 32.11 Ecological Impact of Renewable Energy |
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| 32.12 Future Directions in Clean Energy and Ecotechnology |
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| 33.Topics |
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| 4.1 .12.15.33.1Integration of Electronic Engineering in Construction and Civil Engineering |
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| 33.2.Introduction to Electronic Systems in Civil Engineering |
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| 33.3.Smart Construction Technologies |
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| 33.4.IoT in Infrastructure Management |
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| 33.5.Electronic Monitoring and Control Systems |
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| 33.6.Automation in Construction Machinery |
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| 33.7.Solar and Renewable Energy Systems in Civil Engineering |
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| 33.8.Building Information Modeling (BIM) and Electronic Systems |
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33.9.Cybersecurity in Smart Infrastructure

33.1 Integration of Electronic Engineering in Construction and Civil Engineering

33.2 Introduction to Electronic Systems in Civil Engineering

33.3 Smart Construction Technologies

33.4 IoT in Infrastructure Management

33.5 Electronic Monitoring and Control Systems

33.6 Automation in Construction Machinery

33.7 Solar and Renewable Energy Systems in Civil Engineering

33.8 Building Information Modeling (BIM) and Electronic Systems

33.9 Cybersecurity in Smart Infrastructure

34.1.Topic

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| 4.1 .12.15..34.2.Masters in Immutable Data Storage Solutions for Web Design |
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| 34.3.Introduction to Immutable Data |
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| 33.4.Immutable Data Structures |
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| 33.5.Immutable.js and Alternatives |
| |
| 33.6.State Management with Immutable Data |

33.7.Performance Benefits of Immutable Data

33.8.GraphQL and Immutable Data

33.9.Immutable Data in Server-Side Rendering (SSR)

33.10.Security and Immutable Data

33.11.Future Trends in Immutable Data

Masters in Immutable Data Storage Solutions for Web Design

34.2 Introduction to Immutable Data

34.3 Immutable Data Structures

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| 34.Topic |
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| 4.1 .12.15.34.1.Masters in Immutable Data Storage Solutions for Web Design |
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| 34.2.Introduction to Immutable Data |
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| 34.3.Immutable Data Structures |
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| 34.4.Immutable.js and Alternatives |
| |

34.5.State Management with Immutable Data

34.6.Performance Benefits of Immutable Data

34.6.GraphQL and Immutable Data

34.7.Immutable Data in Server-Side Rendering (SSR)

34.8.Security and Immutable Data

34.9.Future Trends in Immutable Data

34.1 Masters in Immutable Data Storage Solutions for Web Design

34.2 Introduction to Immutable Data

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| 34.3 Immutable Data Structures |
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| 4.1 .12.15..35.2.Advanced Cyber-Physical Systems in Telecommunications |
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| 35.3.Introduction to Cyber-Physical Systems |
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| 35.4.Network Architecture in CPS |

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| 35.5..IoT and Cyber-Physical Systems |
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| 35.6.Security and Privacy in CPS |
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| 35.7.Real-time Data Processing and Analytics |
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| 35.8.Machine Learning in Cyber-Physical Systems |
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| 35.9.Emerging Trends in CPS and Telecommunications |
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35.10.CPS Case Studies in Telecommunications

35.2 Advanced Cyber-Physical Systems in Telecommunications

35.3 Introduction to Cyber-Physical Systems

35.4 Network Architecture in CPS

35.5 IoT and Cyber-Physical Systems

35.6 Security and Privacy in CPS

35.7 Real-time Data Processing and Analytics

35.8 Machine Learning in Cyber-Physical Systems

35.9 Emerging Trends in CPS and Telecommunications

35.10 CPS Case Studies in Telecommunications

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36. Topics:

37. Master's Program in Artificial Intelligence and Machine Learning for Software Engineering

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| 4.1 .12.15..36.1.Introduction to Artificial Intelligence and Machine Learning |
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| 36.2.Data Preprocessing and Feature Engineering |
| |
| 36.3.Supervised Learning Techniques |
| |
| 36.4.Unsupervised Learning and Clustering |
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| 36.5.Deep Learning and Neural Networks |
| |
| 36.6.Natural Language Processing |
| |
| 36.7.AI/ML in Software Development Lifecycle |
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| 36.8.Ethical and Responsible AI |
| |
| 36.8.Deployment and Scaling of AI Solutions |
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37.1 Master's Program in Artificial Intelligence and Machine Learning for Software Engineering

37.2 Introduction to Artificial Intelligence and Machine Learning

37.3 Data Preprocessing and Feature Engineering

37.4 Supervised Learning Techniques

37.5 Unsupervised Learning and Clustering

37.6 Deep Learning and Neural Networks

37.7 Natural Language Processing

37.8 AI/ML in Software Development Lifecycle

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| 37.9 Ethical and Responsible AI |
| |
| 37.10 Deployment and Scaling of AI Solutions |
| 37..Topics: |
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| 4.1 .12.15.37.1.Advanced Studies in Autonomous Vehicles and Drones for Electric Vehicle Engineering |
| |
| 37.1.Introduction to Autonomous Systems |
| 37.2Electric Vehicle Engineering Basics |
| |
| 37.3.Sensor Technologies and Data Processing |
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| 37.4.Machine Learning and AI for Autonomous Systems |
| |
| 37.5.Communication Networks and IoT |
| |
| 37.6.Control Systems for Autonomous Vehicles |
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| 37.7Ethical and Regulatory Aspects |
| |
| 37.8.Testing and Validation of Autonomous Systems |

37.9.Integration of Renewable Energy in Autonomous Systems

37.1 Advanced Studies in Autonomous Vehicles and Drones for Electric Vehicle Engineering

37.2 Introduction to Autonomous Systems

37.3 Electric Vehicle Engineering Basics

37.4 Sensor Technologies and Data Processing

37.5 Machine Learning and AI for Autonomous Systems

37.6 Communication Networks and IoT

37.7 Control Systems for Autonomous Vehicles

37.8 Ethical and Regulatory Aspects

37.9 Testing and Validation of Autonomous Systems

37.10 Integration of Renewable Energy in Autonomous Systems

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| 38.1.topics |
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| 4.1 .12.15.38.2:Specialist Engineering in Infrastructure and Contractors: Electrochemical Engineering |
| |
| 38.3.Introduction to Electrochemical Engineering |
| |
| 38.4.Battery Technologies for Infrastructure |
| |

38.5.Fuel Cells and Their Applications

38.6.and Its Prevention

38.7..Electrochemical Sensors and Monitoring

38.8.Electrolysis and Industrial Processes

38.9.Sustainability and Electrochemical Engineering

.38.10.Advanced Topics in Electrochemical Engineering

38.2 Specialist Engineering in Infrastructure and Contractors: Electrochemical Engineering

38.3 Introduction to Electrochemical Engineering

38.4 Battery Technologies for Infrastructure

38.5 Fuel Cells and Their Applications

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| 38.6 Corrosion and Its Prevention |
| |
| 38.7 Electrochemical Sensors and Monitoring |
| 38.8 Electrolysis and Industrial Processes |
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38.9 Sustainability and Electrochemical Engineering

38.10 Advanced Topics in Electrochemical Engineering

4.1 .12.15..40.1Topics:Energy Storage and Battery Technology

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|---|
| 40.2.Introduction to Energy Storage Systems |
| |
| 40.3.Battery Chemistry and Physics |
| |
| 40.4.Design and Functionality of Battery Cells |
| |
| 40.5.Applications of Battery Storage |
| |
| 40.6.Efficiency and Performance Measurements |
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| 40.7.Safety and Environmental Impacts |
| |
| 40.8.Advanced Energy Storage Technologies |
| |
| 40.9.Policy and Economics of Energy Storage |
| 40.10.Future Trends in Battery Technology |
| |
| 41.1.Topics: |
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41.2.Advanced Robotic Process Automation in Electrical Engineering

41.3.Introduction to Robotic Process Automation

41.4.RPA Tools and Technologies

41.5.Automating Electrical Design Processes

41.6.Data Migration and Management

41.7.RPA in Control Systems

41.8.Machine Learning and RPA

41.9.RPA and IoT in Electrical Systems

41.10.Security and Ethics in RPA

1.2 Advanced Robotic Process Automation in Electrical Engineering

41.3 Introduction to Robotic Process Automation

41.4 RPA Tools and Technologies

41.5 Automating Electrical Design Processes

41.6 Data Migration and Management

41.7 RPA in Control Systems

41.8 Machine Learning and RPA

41.9 RPA and IoT in Electrical Systems

41.10 Security and Ethics in RPA

44..1. Define the Problem

2. Develop the Mathematical Model

| |
|---|
| 3. Simplify the Equations |
| |
| 4. Analytical Solution (if possible) |
| |
| 5. Numerical Solution (if necessary) |
| |
| 6. Simulation and Validation |
| |

7. Optimization (if applicable)

Example Calculation: Load Flow Analysis in Power Systems

1. Circuit Analysis

2. Electromagnetics

3. Signal Processing

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| 4. Control Systems |
| |
| 5. Power Systems |
| |
| 6. Electronics |
| |
| 7. Digital Systems |
| |
| 8. Communication Systems |
| |
| 9. Renewable Energy Systems |
| |
| 1. Circuit Analysis |
| |

2. Electromagnetics

3. Signal Processing

4. Control Systems

5. Power Systems

6. Electronics

7. Digital Systems

8. Communication Systems

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| 9. Renewable Energy Systems |
| |
| . Circuit Design and Analysis |
| |
| 2. Power Systems Engineering |
| |
| 3. Control Systems |
| |
| 4. Communication Systems |
| |

5. Electronics and Semiconductor Design

6. Renewable Energy Systems

7. Building and Infrastructure

8. Biomedical Engineering

1. Signal Processing

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| 2. Communication Systems |
| |
| 3. Information Theory |
| |
| 4. Network Theory |
| |
| 5. Electromagnetic Theory |
| |
| 6. Digital Communication |
| |
| 1. Signal Processing |
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| 2. Communication Systems |
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| 3. Information Theory |
| |
| 4. Network Theory |
| |
| 5. Electromagnetic Theory |
| |
| 6. Digital Communication |
| |
| Practical Examples: |
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|---|
| IoT (Internet of Things) |
| |
| Solar Power Systems |
| |
| Wind Energy Projects |
| |
| Communication Systems Calculations |
| |
| 1. MIMO (Multiple Input Multiple Output) Systems |

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| |
| 2. Satellite Communication |
| |
| 3. Optical Fiber Communication |
| |
| 4. IoT (Internet of Things) |
| |
| Ancient Times |
| |
| System Design and Operation |
| |

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| Battery Technologies for Infrastructure |
| |
| 34.6 Performance Benefits of Immutable Data |
| |
| 38.7 Electrochemical Sensors and Monitoring |
| |

38.8 Electrolysis and Industrial Processes

38.9 Sustainability and Electrochemical Engineering

5. Automating Electrical Design Processes

Integral and Derivative Calculations in Automating Electrical Design Processes

Project Management in Electrical Engineering

Integral and Derivative Calculations in Project Management

Wind Energy, Solar Energy, and Hydroelectric Power

Electrical Infrastructure Design and Management

Smart Grids and IoT Applications

Understanding the Basic Concepts of Social Media Marketing

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| Television and Radio Production Essentials |
| |
| Roberto Aldrett - AIU |
| |
| Career Coach |
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| Life-Coach Consulting |
| |
| The Future Of Science and Engineering |
| |

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| The Constantly Changing Education Landscape |
| |
| Academic Freedom to Discover Your Purpose Open Curriculum Design at Atlantic International University |
| |
| Core Courses and Topics in Engineering Systems: |

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| Orientation Courses: |
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| Research Project in Engineering Systems: |
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| Academic Freedom to Discover Your Purpose Open Curriculum Design at Atlantic International University |
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| Core Courses and Topics in Engineering Systems: |
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| Orientation Courses: |
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| Research Project in Engineering Systems: |
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| Academic Freedom to Discover Your Purpose Open Curriculum Design at Atlantic International University |

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| Core Courses and Topics in Engineering Systems: |
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| Orientation Courses: |
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| Research Project in Engineering Systems: |
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| Student_name : tshingombe_tshitadi |
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| 1 topics : |
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| 1 AGI in Human-Machine Collaboration |
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| Future Scenarios of AGI Development |
| |
| 1.10nline Retail and E-commerce in the Renewable Energy Sector |
| |
| 1.2 Introduction to E-commerce in the Renewable Energy Sector |
| |
| 1.3 Understanding the Renewable Energy Market |

Targeted, flexible and co-ordinated policies can unlock the potential of e-commerce

1.4. E-commerce Strategies for Renewable Energy Products

1.4 Consumer Behavior in Online Retail

3.1 Electric power B2B descriptions

3.2 Notations

1.5 Digital Marketing for Renewable Energy E-commerce

1.6. Sustainable Practices in E-commerce

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| 1.7 Case Studies in Renewable Energy E-commerce: |
| |
| 3.3 Fusion of behavioral data |
| |
| 3.4 Fusion of item attribute information |
| |

3.5 Fusion of behavioral data and item information

1.8 Regulatory Environment for Online Retail in Renewable Energy:

Experiments and discussion

4.1 Data descriptions

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| 1.9 Future Trends in Online Retail and Renewable Energy |
| |
| Future Research Frontiers in AI for the E-commerce Sector |
| |
| 2.1Publishing and Natural Resources Management: |
| |
| 2.2 Introduction to Sustainable Natural Resources Management: |

This topic covers the fundamental principles of sustainable natural resource management and its importance for future generations. Challenges in natural resource management for ecological sustainability

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| 2.3.1 Resource planning strategy and ownership regime |
| |
| 2.3 The Role of Publishing in Sustainability: |
| |
| 2.4 Environmental Journalism and Communication |
| |
| 2.5 Digital Publishing and New Media |
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| 2.6 Content Creation for Natural Resource Management |
| |
| 2.2. New journals on SDG-relevant topics |
| |
| 2.8 Sustainable Practices in Publishing: |
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| 2.9. Case Studies in Effective Sustainability Communication: |
| |
| 3.3. Equity recommended |
| |
| |
| 4. Translating research into practice |
| |
| 4.1. Cognitive accessibility |
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3.1 Masters in Supply Chain Management and Traceability

3.2 Introduction to Supply Chain Management

between functions within their own companies, but also with other An Introduction to Supply Chain Management

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| 3.3. Principles of Traceability |
| |
| 3.4 Software Engineering Basics: |
| |
| 3.5 Supply Chain Digitalization |
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| 3.6 Data Management in Supply Chains |
| |
| 3.7 Blockchain for Supply Chain Traceability |
| |
| IoT and Smart Supply Chains |
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| 3.8 Security and Privacy in Supply Chain Software: |
| |
| 3.9 Case Studies and Real-world Applications |
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| |
| 4.1 Social Media Marketing for Real Estate, Rental, and Leasing |
| |

4.1 Social Media Marketing for Real Estate, Rental, and Leasing

4.2 Introduction to Social Media Marketing

4.2 Introduction to Social Media Marketing

Understanding the basic concepts of social media marketing and its importance in the real estate, rental, and leasing sectors.: Understanding the Basic Concepts of Social Media Marketing

Importance of Social Media Marketing
in Real Estate, Rental, and Leasing

4.3 Target Audience Analysis

4.4 Content Creation for Real Estate

Strategies for creating compelling content that attracts and retains the interest of potential clients on social media.: Target Audience Analysis for Real Estate, Rental, and Leasing on Social Media

4.5 Platform-Specific Strategies:

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| Learning to tailor marketing strategies for different social media platforms such as Facebook, Instagram, and LinkedIn.: Platform-Specific Strategies for Social Media Marketing |
| |
| 4.6 Social Media Advertising: |
| |
| Engagement and Community Building: |
| |

Metrics and Analytics: Engagement and Community Building

Case Studies and Best Practices

4.6 Case Studies and Best Practices

5.1 Advanced Telemedicine and Remote Healthcare Production

5.2 Introduction to Telemedicine and Remote Healthcare: Advanced Telemedicine and Remote Healthcare Production

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| 5.3 Television and Radio Production Essentials: |
| |
| 5.4 Medical Narrative and Storytelling |
| |

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| Crafting compelling stories that communicate complex healthcare concepts effectively to a diverse audience.: 5.3 Television and Radio Production Essentials |
| |
| 5.6 Remote Healthcare Technologies and Innovations: |
| |

5.9 Audience Engagement and Feedback in Healthcare Broadcasting

5.11 Future Trends in Telemedicine and Media Integration

6.1 Technical Writing for Technology

6.2 Introduction to Technical Writing

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| 6.3 Understanding Your Audience: |
| |
| 6.9 Editing and Proofreading: Editing and Proofreading |
| 6.10 Ethics in Technical Writing |
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| 6.10 Ethics in Technical Writing |
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| 6.12  Effective Communication in Teams |
| |
| 7.1.Masters in Vertical Farming and Urban Agriculture with Focus on Synthetic Biology |
| |
| 7.2Introduction to Vertical Farming and Urban Agriculture |
| |
| 7.3.Fundamentals of Synthetic Biology |

Study the basic principles of synthetic biology, including DNA sequencing, genetic engineering, and how these tools are used to optimize plant growth.: Fundamentals of Synthetic Biology

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| 7.4..Applications of Synthetic Biology in Urban Agriculture |
| |
| 7.6Design of Vertical Farming Systems |
| |
| 7.7Integration of Biotechnology in Crop Production |
| |
| 7.8.Environmental and Economic Impacts of Urban Agriculture |
| |

7.9.Regulatory and Ethical Considerations in Synthetic Biology

7.10Future Trends in Vertical Farming and Synthetic Biology

8.Master's in Urban Water Supply, Sewerage, Waste Management, and Remediation Activities

8.2.Introduction to Urban Water Supply Systems

8.3 Sewerage Systems Design and Manage

8.3.Sewerage Systems Design and Management

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| Learn about the engineering, design, and operational management of urban sewerage systems, focusing on sustainable practices and innovations in waste treatment and resource recovery.: Sewerage Systems Design and Management |
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| 8.4.Urban Waste Management Strategies |
| |
| 8.5.Remediation Activities and Technologies |

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| |
| 8.6.Policy and Regulation in Urban Water and Waste |
| |
| 8.7.Climate Change and its Impact on Water and Waste Management |
| |
| 8.8..Sustainable Innovations in Water and Waste Systems |
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| 9.1.Transportation and Warehousing in Tourism Planning and Development |
| |
| 9.2..Introduction to Tourism Logistics |
| |
| |
| 9.3…Transportation Infrastructure in Tourism |
| |
| 9.4..Role of Warehousing in Tourism |
| |
| 9.5..Sustainable Transport Solutions |
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| 9.6..Tourism Supply Chain Management |
| |
| 9.7.Policy and Regulations in Tourism Transport |
| |
| 9.8.Innovations in Tourism Warehousing |
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| Investigates recent technological advancements in warehousing that support tourism industry needs. 9.8 Innovations in Tourism Warehousing |
| |
| 9.9..Case Studies on Tourism and Logistics |
| |
| 10.1..Spatial Computing in Telecommunications |

10.2..Introduction to Spatial Computing

10.3..Spatial Data and Telecommunications

10.4..Geographical Information Systems (GIS) in Telecom

10.5..Network Planning and Optimization Using Spatial Computing

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| 10.6.Spatial Data Analytics for Telecom |
| |
| 10.7..Augmented Reality (AR) in Telecommunication Services |
| |
| 10.11..5G and Spatial Computing |
| |
| 10.12..Privacy and Security in Spatial Telecommunications |
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| 11.1..Advanced Legal Studies in Public Administration and Safety |
| |
| 11.2Introduction to Public Law |
| |
| 11.3.Constitutional Law and Governance |
| |
| 11.4.Administrative Law |
| |
| 11.5.Legal Frameworks for Public Safety |
| |
| 11.6..Ethics in Public Administration |

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| |
| 11.7..Public Policy and Legal Implications |
| |
| 11.8..Human Rights and Social Justice |
| |
| 11.9.Crisis Management and Legal Compliance |
| |
| 12.1Metallurgy in Oil and Gas Production, Refining, and Transport |
| |

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|---|
| 12.2..Introduction to Metallurgy in Oil and Gas |
| |
| 12.3..Material Selection for Oil and Gas Production |
| |
| 12.4..Corrosion Mechanisms and Prevention |
| |
| 12.5..Metallurgical Processes in Refining |
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| Discusses how metallurgical processes like heat treatment and welding are utilized in refining operations to enhance material properties.<br>Corrosion Mechanisms and Prevention |
| |
| 12.6..Pipeline Materials and Design |
| |
| 12.7.Advanced Coatings and Surface Treatments |
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| Advanced Coatings and Surface Treatments |
| |
| 12.8.Environmental Impact and Sustainability in Metallurgy |
| |
| 12.9..Failure Analysis and Case Studies |
| |
| 12.10Future Trends in Metallurgy for Oil and Gas |
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| 13.1.Integrated Water Management in Mining |
| |
| 13.2.Introduction to Mining Water Management |
| |
| 13.2.Water Resource Evaluation and Planning |
| |
| 13.3.Water Quality Management in Mining |
| |
| 13.4.Regulatory and Environmental Compliance |
| |

13.5.Innovation and Technology in Water Management

13.6.Stakeholder Engagement and Social License

13.7..Climate Change Impacts on Water Resources

13.8.Case Studies and Best Practices

13.7.Future Trends in Mining Water Management

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| |
| 3.1 Integrated Water Management in Mining |
| |
| 13.2 Introduction to Mining Water Management |
| |
| 13.3 Water Resource Evaluation and Planning |

13.4 Water Quality Management in Mining

13.5 Regulatory and Environmental Compliance

13.6 Innovation and Technology in Water Management

13.7 Stakeholder Engagement and Social License

13.8 Climate Change Impacts on Water Resources

13.9 Case Studies and Best Practices

13.10 Future Trends in Mining Water Management

14.Integrated Water Management in Mining

14.1.Introduction to Mining Water Management

14.2.Water Resource Evaluation and Planning

14.3Water Quality Management in Mining

14.4.Regulatory and Environmental Compliance

14.5.Innovation and Technology in Water Management

14.6..Stakeholder Engagement and Social License

14.7Climate Change Impacts on Water Resources

14.8..Case Studies and Best Practices

14..9..Future Trends in Mining Water Management

14 Integrated Water Management in Mining

14.1 Introduction to Mining Water Management

14.2 Water Resource Evaluation and Planning

14.3 Water Quality Management in Mining

14.4 Regulatory and Environmental Compliance

14.5 Innovation and Technology in Water Management

14.6 Stakeholder Engagement and Social License

14.7 Climate Change Impacts on Water Resources

14.8 Case Studies and Best Practices

14.9 Future Trends in Mining Water Management

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| 15.1.Advanced Manufacturing Techniques in Genetic Engineering |
| |
| 15.2.Introduction to Genetic Engineering |
| |
| 15.3..Manufacturing Processes in Biotechnology |
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| 15.4..CRISPR and Advanced Genetic Modification Techniques |

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| 15.5.Ethical and Regulatory Considerations |
| |
| 15.6.Biopharmaceutical Manufacturing |
| |
| 15.7.Fermentation Technology |
| |
| 15.8..Scale-Up and Commercialization |
| |
| 15.9.Quality Control in Genetically Engineered Products |
| |

15.10.Future Trends in Genetic Engineering Manufacturing

15.1.Advanced Manufacturing Techniques in Genetic Engineering

15.2.Introduction to Genetic Engineering

15.3..Manufacturing Processes in Biotechnology

15.4..CRISPR and Advanced Genetic Modification Techniques

15.5.Ethical and Regulatory Considerations

15.6.Biopharmaceutical Manufacturing

15.7.Fermentation Technology

15.8..Scale-Up and Commercialization

15.9.Quality Control in Genetically Engineered Products

15.10.Future Trends in Genetic Engineering Manufacturing

16.1.Data Processing and Hosting Services in Computer Engineering

16.2.Introduction to Data Processing

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| 16.3.Cloud Hosting Services |
| |
| 16.4..Big Data Technologies |
| |
| 16.5Data Security in Cloud Hosting |
| |
| 16.6.Containerization and Microservices |
| |
| 16.7Distributed Systems |
| |
| 16.8.Data Warehousing and Analytics |
| |
| 16.9..Serverless Computing |

16.1 Data Processing and Hosting Services in Computer Engineering

16.2 Introduction to Data Processing

16.3 Cloud Hosting Services

16.4 Big Data Technologies

16.5 Data Security in Cloud Hosting

16.6 Containerization and Microservices

16.7 Distributed Systems

16.8 Data Warehousing and Analytics

16.9 Serverless Computing

17.1.Masters in Cryptocurrency and Blockchain Applications

17.2.Introduction to Blockchain Technology

17.2.Cryptocurrencies: An Overview

17.3.Blockchain Consensus Mechanisms

17.4..Smart Contracts

17.5.Decentralized Finance (DeFi)

17.6.Blockchain in Supply Chain Management

17.7.Regulation and Compliance in Blockchain

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| |
| 17.8.NFTs and Digital Assets |
| |
| 17.1 Masters in Cryptocurrency and Blockchain Applications |
| |
| 17.2 Introduction to Blockchain Technology |
| |

17.3 Cryptocurrencies: An Overview

17.4 Blockchain Consensus Mechanisms

17.5 Smart Contracts

17.6 Decentralized Finance (DeFi)

17.7 Blockchain in Supply Chain Management

17.8 Regulation and Compliance in Blockchain

17.9 NFTs and Digital Assets

18.1.Advanced Cybersecurity in Bibliotechnology

18.2.Introduction to Cybersecurity in Bibliotechnology

18.3Threats and Vulnerabilities in Digital Libraries

18.4.Data Privacy and Integrity in Bibliotechnology

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| 18.5.Implementing Security Policies for Digital Libraries |
| |
| 18.6.Access Control in Library Networks |
| |
| 18.7.Digital Rights Management in Bibliotechnology |
| |
| 18.8.Network Security Essentials for Digital Libraries |
| |

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| 18.9.Incident Response and Recovery for Digital Libraries |
| |
| 18..10Emerging Cybersecurity Technologies in Bibliotechnology |
| 18.1 Advanced Cybersecurity in Bibliotechnology |
| |

18.2 Introduction to Cybersecurity in Bibliotechnology

18.3 Threats and Vulnerabilities in Digital Libraries

18.4 Data Privacy and Integrity in Bibliotechnology

18.5 Implementing Security Policies for Digital Libraries

18.6 Access Control in Library Networks

18.7 Digital Rights Management in Bibliotechnology

18.8 Network Security Essentials for Digital Libraries

18.9 Incident Response and Recovery for Digital Libraries

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| 18.10 Emerging Cybersecurity Technologies in Bibliotechnology |
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| 19.1.1Edge Computing in Modern Power and Energy Systems |
| |
| 19.2..Introduction to Edge Computing |
| |
| 19.3.Distributed Computing in Energy Systems |

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| |
| 19.4.IoT Applications in Power Systems |
| |
| 19.5.Real-time Data Processing |
| |
| 19.6Security and Privacy in Edge Computing |
| |
| 19.6.Edge Analytics for Energy Management |
| |
| 19.7.Energy Efficiency Optimization |
| |

19.8.Case Studies on Edge Computing in Energy

19.9.Future Trends in Edge Computing for Energy Systems

19.1 Edge Computing in Modern Power and Energy Systems

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|---|
| 19.2 Introduction to Edge Computing |
| |
| 19.3 Distributed Computing in Energy Systems |
| |
| 19.4 IoT Applications in Power Systems |
| |

19.5 Real-time Data Processing

19.6 Security and Privacy in Edge Computing

19.7 Edge Analytics for Energy Management

19.8 Energy Efficiency Optimization

19.9 Case Studies on Edge Computing in Energy

19.10 Future Trends in Edge Computing for Energy Systems

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| |
| Edge Computing for Modern Power and Energy Systems |
| |
| Introduction to Edge Computing |
| |
| Role of Edge Computing in Smart Grids |
| |
| Edge Computing for Renewable Energy Integration |
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| Data Management and Security in Edge Computing |

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| |
| Machine Learning Applications on the Edge |
| |
| Case Studies in Edge Computing for Energy Systems |
| |
| Challenges and Future Trends |
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| 20.1.Masters in Cyber-Physical Systems and Information Technology |
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| 20.2.Introduction to Cyber-Physical Systems |
| |
| 20.3.Architecture of CPS |
| |
| 20.4Networking and Communication in CPS |
| |
| 20.5.CPS Security and Privacy |
| |
| 20.6.Machine Learning in CPS |
| |
| 20.7.Real-Time Systems and CPS |
| |
| 20.8.Simulation and Modeling in CPS |

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| 20.9..Applications and Case Studies of CPS |
| |
| 20.1 Masters in Cyber-Physical Systems and Information Technology |
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| 20.2 Introduction to Cyber-Physical Systems |
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| 20.3 Architecture of CPS |
| |
| 20.4 Networking and Communication in CPS |
| |
| 20.5 CPS Security and Privacy |
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| 20.6 Machine Learning in CPS |
| |

20.7 Real-Time Systems and CPS

20.8 Simulation and Modeling in CPS

20.9 Applications and Case Studies of CPS

21.1.Masters in Distributed-Ledger Technology Applications in Educational Technology

21.1. Introduction to Distributed Ledger Technology

21.2.The Need for Distributed Ledger Technology in Education

21.3.Blockchain for Secure Credentialing

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| |
| 21.4.Smart Contracts in Educational Transactions |
| |
| 21.5..DLT-based Learning Management Systems |
| |
| Privacy and Data Security in DLT |
| |
| 21.6.Case Studies of DLT in Education |
| |
| 21.7.Future Trends in DLT and EdTech |

21.1 Masters in Distributed-Ledger Technology Applications in Educational Technology

21.2 Introduction to Distributed Ledger Technology

21.3 The Need for Distributed Ledger Technology in Education

21.4 Blockchain for Secure Credentialing

21.5 Smart Contracts in Educational Transactions

21.6 DLT-based Learning Management Systems

21.7 Privacy and Data Security in DLT

21.8 Case Studies of DLT in Education

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| 21.9 Future Trends in DLT and EdTech |
| |
| 22.1.Master's in Adult Education Services |
| |
| 22.1.Introduction to Adult Education |
| |
| 22.2.Theories of Adult Learning |
| |
| 22.3.Curriculum Design for Adult Learners |
| |

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| 22.4.Assessment and Evaluation in Adult Education |
| |
| 22.5.Technology Integration in Adult Learning |
| |
| 22.6.Diversity and Inclusion in Adult Education |
| |
| 22.7.Motivational Strategies for Adult Learners |
| |

22.8.Professional Development for Adult Educators

22.1 Master's in Adult Education Services

22.2 Introduction to Adult Education

22.3 Theories of Adult Learning

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| |
| 22.4 Curriculum Design for Adult Learners |
| |
| 22.5 Assessment and Evaluation in Adult Education |
| |
| 22.6 Technology Integration in Adult Learning |

22.7 Diversity and Inclusion in Adult Education

22.8 Motivational Strategies for Adult Learners

22.9 Professional Development for Adult Educators

23.1Quantum Computing in Systems Engineering

23.1.Introduction to Quantum Computing

23.2.Quantum Algorithms

22.3.Quantum Gates and Circuits

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| |
| 22.4.Quantum Information Theory |
| |
| 22.5.Quantum Computing Platforms |
| |
| 22.6.Quantum Programming Languages |
| 22.7.Applications of Quantum Computing in Systems Engineering |
| |

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| 22.8.Challenges and Future of Quantum Computing |
| |
| 22.9.Quantum Supremacy and its Implications |
| |
| 23.1 Quantum Computing in Systems Engineering |
| |
| 23.1 Introduction to Quantum Computing |

23.2 Quantum Algorithms

23.3 Quantum Gates and Circuits

23.4 Quantum Information Theory

23.5 Quantum Computing Platforms

23.6 Quantum Programming Languages

23.7 Applications of Quantum Computing in Systems Engineering

23.8 Challenges and Future of Quantum Computing

23.9 Quantum Supremacy and its Implications

23.2.Neurotechnology in Educational Technology

23.3.Introduction to Neurotechnology

23.4.Neuroscience Basics for Educators

23.5.Brain-Computer Interfaces in Education

23.6.Cognitive Load Theory and Neurotechnology

23.7.Neuroscience-Based Adaptive Learning Technologies

23.8.Ethical and Social Implications

23.9.Case Studies in Neurotechnology Education

23.10.Future Trends in Neurotechnology for Education

23.2 Neurotechnology in Educational Technology

23.3 Introduction to Neurotechnology

23.4 Neuroscience Basics for Educators

23.5 Brain-Computer Interfaces in Education

23.6 Cognitive Load Theory and Neurotechnology

23.7 Neuroscience-Based Adaptive Learning Technologies

23.8 Ethical and Social Implications

23.9 Case Studies in Neurotechnology Education

23.10 Future Trends in Neurotechnology for Education

24.1.Robotic Process Automation in Electrochemical Engineering

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| |
| 24.2Introduction to Robotic Process Automation |
| |
| 24.3.Fundamentals of Electrochemical Engineering |
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| 24.4.RPA Tools and Platforms |
| |
| 24.5.Automating Electrochemical Process Controls |
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24.7 Machine Learning and RPA in Electrochemical Engineering

24.8 RPA Implementation Challenges and Solutions

24.9 Case Studies and Industry Applications

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| 25.6.Virtual Labs and Simulations |
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25.7.Assessing Learner Outcomes in Technology-Driven Curriculum

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25.7 Assessing Learner Outcomes in Technology-Driven Curriculum

25.8 Case Studies in Renewable Energy Education

25.9 Challenges in Integrating Technology and Renewable Energy Education

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26.2.Introduction to Wholesale Trade

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| 26.9 Regulatory and Ethical Considerations |
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| 29.2.Introduction to Wireless Communications |

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| 29.6.Wireless Networking and Protocols |
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29.1 Advanced Wireless Communications

29.2 Introduction to Wireless Communications

29.3 Radio Frequency Fundamentals

29.4 Wireless Signal Propagation

29.5 Multiple Access Techniques

29.6 Wireless Networking and Protocols

29.7 Cellular Systems and 5G

29.8 Antenna Theory and Design

29.9 Wireless Security

29.10 IoT and Wireless Sensor Networks

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| 30.2. Fundamentals of Electrical Systems in Construction |
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| 30.3.Electrical Safety Standards and Codes |
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| 30.4.Integration of Electrical Systems in Building Design |
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| 30.5Sustainable and Renewable Energy Technologies |
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30.2 Fundamentals of Electrical Systems in Construction

30.3 Electrical Safety Standards and Codes

30.4 Integration of Electrical Systems in Building Design

30.5 Sustainable and Renewable Energy Technologies

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| 30.6 Smart Grids and Intelligent Networks |
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| 30.7 Electrical System Design and Simulation |
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| 30.8 Power Quality and Energy Management |

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| 30.2.Advanced Power System Analysis |
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| 31.6..High Voltage Engineering |
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| 31.7.Project Management in Electrical Engineering |
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31.8Energy Policy and Ethical Considerations

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31.6 High Voltage Engineering

31.7 Project Management in Electrical Engineering

31.8 Energy Policy and Ethical Considerations

31.9 Sustainable Electrical Engineering Practices

Admission Ready - Completing your application - Atlantic International University

32.Topic

32.1Clean Energy Technology: Ecotechnology Applications

32.3.Introduction to Clean Energy and Ecotechnology

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| 32.5.Wind Energy Systems |
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| 32.6.Bioenergy and Biomass |
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| 32.7.Hydropower and Ocean Energy |
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| 32.12.Future Directions in Clean Energy and Ecotechnology |
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32.3 Introduction to Clean Energy and Ecotechnology

32.4 Solar Energy Technologies

32.5 Wind Energy Systems

32.6 Bioenergy and Biomass

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| 32.7 Hydropower and Ocean Energy |
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| 32.8 Geothermal Energy |
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| 32.9 Energy Storage and Smart Grids |
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| 32.10 Policy and Economics of Clean Energy |

32.11 Ecological Impact of Renewable Energy

32.12 Future Directions in Clean Energy and Ecotechnology

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33.1Integration of Electronic Engineering in Construction and Civil Engineering

33.2.Introduction to Electronic Systems in Civil Engineering

33.3.Smart Construction Technologies

33.4.IoT in Infrastructure Management

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| 33.5.Electronic Monitoring and Control Systems |
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| 33.6.Automation in Construction Machinery |
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| 33.7.Solar and Renewable Energy Systems in Civil Engineering |
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| 33.8.Building Information Modeling (BIM) and Electronic Systems |
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33.3 Smart Construction Technologies

33.4 IoT in Infrastructure Management

33.5 Electronic Monitoring and Control Systems

33.6 Automation in Construction Machinery

33.7 Solar and Renewable Energy Systems in Civil Engineering

33.8 Building Information Modeling (BIM) and Electronic Systems

33.9 Cybersecurity in Smart Infrastructure

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34.2.Masters in Immutable Data Storage Solutions for Web Design

34.3.Introduction to Immutable Data

33.4.Immutable Data Structures

33.5.Immutable.js and Alternatives

33.6.State Management with Immutable Data

33.7.Performance Benefits of Immutable Data

33.8.GraphQL and Immutable Data

33.9.Immutable Data in Server-Side Rendering (SSR)

33.10.Security and Immutable Data

33.11.Future Trends in Immutable Data

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| 34.2 Introduction to Immutable Data |
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| 34.3 Immutable Data Structures |
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| 34.Topic |

34.1.Masters in Immutable Data Storage Solutions for Web Design

34.2.Introduction to Immutable Data

34.3.Immutable Data Structures

34.4.Immutable.js and Alternatives

34.5.State Management with Immutable Data

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| 35.5..IoT and Cyber-Physical Systems |
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| 35.6.Security and Privacy in CPS |

35.7.Real-time Data Processing and Analytics

35.8.Machine Learning in Cyber-Physical Systems

35.9.Emerging Trends in CPS and Telecommunications

35.10.CPS Case Studies in Telecommunications

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35.4 Network Architecture in CPS

35.5 IoT and Cyber-Physical Systems

35.6 Security and Privacy in CPS

35.7 Real-time Data Processing and Analytics

35.8 Machine Learning in Cyber-Physical Systems

35.9 Emerging Trends in CPS and Telecommunications

35.10 CPS Case Studies in Telecommunications

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39. Master's Program in Artificial Intelligence and Machine Learning for Software Engineering

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| 36.2.Data Preprocessing and Feature Engineering |
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| 36.3.Supervised Learning Techniques |
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| 36.4.Unsupervised Learning and Clustering |
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| 36.5.Deep Learning and Neural Networks |
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| 36.6.Natural Language Processing |
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| 36.7.AI/ML in Software Development Lifecycle |
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| 36.8.Ethical and Responsible AI |
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| 36.8.Deployment and Scaling of AI Solutions |
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37.1 Master's Program in Artificial Intelligence and Machine Learning for Software Engineering

37.2 Introduction to Artificial Intelligence and Machine Learning

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37.5 Unsupervised Learning and Clustering

37.6 Deep Learning and Neural Networks

37.7 Natural Language Processing

37.8 AI/ML in Software Development Lifecycle

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| 37.9 Ethical and Responsible AI |
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| 37.10 Deployment and Scaling of AI Solutions |
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| 37.1.Advanced Studies in Autonomous Vehicles and Drones for Electric Vehicle Engineering |

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| 37.1.Introduction to Autonomous Systems |
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| 37.2Electric Vehicle Engineering Basics |
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| 37.3.Sensor Technologies and Data Processing |
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| 37.4.Machine Learning and AI for Autonomous Systems |
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| 37.5.Communication Networks and IoT |

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| 37.6.Control Systems for Autonomous Vehicles |
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| 37.7Ethical and Regulatory Aspects |
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| 37.8.Testing and Validation of Autonomous Systems |
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| 37.9.Integration of Renewable Energy in Autonomous Systems |

37.1 Advanced Studies in Autonomous Vehicles and Drones for Electric Vehicle Engineering

37.2 Introduction to Autonomous Systems

37.3 Electric Vehicle Engineering Basics

37.4 Sensor Technologies and Data Processing

37.5 Machine Learning and AI for Autonomous Systems

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| 37.8 Ethical and Regulatory Aspects |
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| 38.2:Specialist Engineering in Infrastructure and Contractors: Electrochemical Engineering |
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| 38.4.Battery Technologies for Infrastructure |
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| 38.5.Fuel Cells and Their Applications |
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| 38.6.and Its Prevention |

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| 38.7..Electrochemical Sensors and Monitoring |
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| 38.8.Electrolysis and Industrial Processes |
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| 38.9.Sustainability and Electrochemical Engineering |
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| 40.2.Introduction to Energy Storage Systems |
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| 40.4.Design and Functionality of Battery Cells |
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| 40.5.Applications of Battery Storage |
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| 40.6.Efficiency and Performance Measurements |
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| 40.7.Safety and Environmental Impacts |
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| 40.8.Advanced Energy Storage Technologies |
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| 40.9.Policy and Economics of Energy Storage |
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| 40.10.Future Trends in Battery Technology |
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| 41.1.Topics: |
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| 41.3.Introduction to Robotic Process Automation |
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41.4.RPA Tools and Technologies

41.5.Automating Electrical Design Processes

41.6.Data Migration and Management

41.7.RPA in Control Systems

41.8.Machine Learning and RPA

41.9.RPA and IoT in Electrical Systems

41.10.Security and Ethics in RPA

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41.3 Introduction to Robotic Process Automation

41.4 RPA Tools and Technologies

41.5 Automating Electrical Design Processes

41.6 Data Migration and Management

41.7 RPA in Control Systems

41.8 Machine Learning and RPA

41.9 RPA and IoT in Electrical Systems

41.10 Security and Ethics in RPA

44..1. Define the Problem

2. Develop the Mathematical Model

3. Simplify the Equations

4. Analytical Solution (if possible)

5. Numerical Solution (if necessary)

| |
|---|
| 6. Simulation and Validation |
| |
| 7. Optimization (if applicable) |
| |
| Example Calculation: Load Flow Analysis in Power Systems |
| |
| 1. Circuit Analysis |
| |

2. Electromagnetics

3. Signal Processing

4. Control Systems

5. Power Systems

6. Electronics

7. Digital Systems

8. Communication Systems

| |
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| 9. Renewable Energy Systems |
| |
| 1. Circuit Analysis |
| |
| 2. Electromagnetics |
| |
| 3. Signal Processing |
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| 4. Control Systems |
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| 5. Power Systems |
| |
| 6. Electronics |
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| 7. Digital Systems |
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| 8. Communication Systems |
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| 9. Renewable Energy Systems |
| |
| . Circuit Design and Analysis |
| |
| 2. Power Systems Engineering |
| |
| 3. Control Systems |

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| 4. Communication Systems |
| |
| 5. Electronics and Semiconductor Design |
| |
| 6. Renewable Energy Systems |
| |
| 7. Building and Infrastructure |
| |

8. Biomedical Engineering

1. Signal Processing

2. Communication Systems

3. Information Theory

4. Network Theory

5. Electromagnetic Theory

6. Digital Communication

1. Signal Processing

2. Communication Systems

3. Information Theory

4. Network Theory

5. Electromagnetic Theory

| |
|---|
| 6. Digital Communication |
| |
| Practical Examples: |
| |
| IoT (Internet of Things) |
| |
| Solar Power Systems |
| |
| Wind Energy Projects |
| |
| Communication Systems Calculations |
| |

| |
|---|
| 1. MIMO (Multiple Input Multiple Output) Systems |
| |
| 2. Satellite Communication |
| |
| 3. Optical Fiber Communication |
| |
| 4. IoT (Internet of Things) |
| |
| Ancient Times |
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System Design and Operation

Battery Technologies for Infrastructure

34.6 Performance Benefits of Immutable Data

38.7 Electrochemical Sensors and Monitoring

38.8 Electrolysis and Industrial Processes

38.9 Sustainability and Electrochemical Engineering

5. Automating Electrical Design Processes

Integral and Derivative Calculations in Automating Electrical Design Processes

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| Project Management in Electrical Engineering |
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| Integral and Derivative Calculations in Project Management |
| |
| Wind Energy, Solar Energy, and Hydroelectric Power |

Electrical Infrastructure Design and Management

Smart Grids and IoT Applications

Understanding the Basic Concepts of Social Media Marketing

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| |
| Television and Radio Production Essentials |
| |
| Roberto Aldrett - AIU |
| |
| Career Coach |
| |
| Life-Coach Consulting |
| |
| Master in Modern Power and Energy Systems |

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| Master in Renewable Energy |
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| Bibliographic Resources |
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| The Future Of Science and Engineering |
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| The Constantly Changing Education Landscape |

Academic Freedom to Discover Your Purpose Open Curriculum Design at Atlantic International University

Core Courses and Topics in Engineering Systems:

Orientation Courses:

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| Research Project in Engineering Systems: |
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| Orientation Course |
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| Research Projects in Doctorate in Electrical Engineering |

Thesis. Degree honor, council quality rules low become justice development court and labor relations conciliation mediation, Engineering electrical trade research policy skill ,safety security order develop ,defense order

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| Course Ciriculum Total Course Thesis Alumine( 1) |
| Reviews (1) |
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| Re: FW: Article submission received #TrackingId:21365851 |
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| Your article submission 161981 |

editorial@f1000research.com

Curriculum section 1:

1.1

Thesis. Degree honor, council quality rules low become justice development court and labor relations conciliation mediation, Engineering electrical trade research policy skill ,safety security order develop ,defense order

On Thu, Apr 3, 2025 at 10:49 AM
tshingombe fiston
<tshingombefiston@gmail.com> wrote:

Career scie bono discovery center.

I

Assessment

Student name :

-author: tshingombe tshitadi

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Career scie bono discovery center.

tshingombe fiston
<tshingombefiston@gmail.com>

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| tshingombe fiston <tshingombefiston@gmail.com> |
| |
| tshingombe fiston <tshingombefiston@gmail.com> |
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| 10.Suggestions for Improvement |
| |
| 1. Clarity and Simplicity |
| |

| |
|---|
| 2. Relevance |
| |
| 3. Organization |
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| 4. Accessibility |
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| 5. Confidentiality |
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| 6. Customization Options |
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| 7. Validation and Error Checking |
| |
| 8. Feedback Mechanism |

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| 9. Aesthetic Design |
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| 10. Test and Iterate |
| |
| Digital Intake Forms |
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| Paper Intake Forms |
| |
| Which is Better? |
| |
| Suggestions for Improvement |
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1. Clarity and Simplicity

2. Relevance

3. Organization

4. Accessibility

5. Confidentiality

6. Customization Options

7. Validation and Error Checking

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| 8. Feedback Mechanism |
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| 9. Aesthetic Design |
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| 10. Test and Iterate |
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| Which is Better? |
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13.1Module Description and Topics for an Experimental Career Curriculum

2.2 Background and Overview

Suggestions for Improvement

13.2Suggestions for Improvements

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| 2.3 Training Science Skills: |
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| 2.4 Study Skills: |
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| 3. Time Management Skills: |
| |

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| 4. Job Search Skills: |
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| 5. Work Readiness: |
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| 6. Self-Directed Career Development: |
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| 7. Learnership and Employment Training: |
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8. Tertiary Studies Information:

9. Career Information Resources:

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| 2.3 Information Management: Expanded Details |
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| 2.3 Training Science Skills: |
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| 2.4 Study Skills: Technical Additions |
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| 3. Time Management Skills: Mathematical Integration |
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| 4. Job Search Skills: Practical Tools |
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| 5. Work Readiness Modules: |
| |

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|---|
| 6. Self-Directed Career Development: |
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| 7. Learnership and Employment Training: |
| 8. Tertiary Studies Information: |
| |

9. Career Information Resources:
Advanced Tools

Expanded Framework for Technical
and Mathematical Integration

14.1 Summary of Background Issues

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| Recommendations for Revision and Improvement |
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| Operational Enhancements |
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| Future Considerations |
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| Course Overview |
| |
| Key Features |
| |

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|---|
| Administrative Information |
| |
| Educational Focus |
| |
| Course Overview |
| |
| Key Features |
| |
| Links to National Occupational Standards (NOS) |
| |
| Skills and Employability |
| |

Equality and Inclusion

Opportunities for Enhancement

Course Summary

Mandatory Units (Total: 24 SCQF Credit Points)

Key Features

| |
|---|
| Links to National Occupational Standards (NOS) |
| |
| Teaching and Learning Approaches |
| |
| Employability Skills: |
| |
| Key Rationale |
| |
| Key Features and Services Provided by SQA |

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| Core Educational Guidance |
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| Recommendations for Enhancements |
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| Pre-Exam Preparations |
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| On Exam Day |
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| Writing the Exam |
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| Conduct and Fairness |
| |

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| Post-Exam Support |
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| 1. Support Systems and Services |
| |
| 2. Skills Development through Qualifications |
| |
| 3. Centre Approval Process |
| |

| |
|---|
| 4. Accessible Learning Resources |
| |
| 5. Research and Development |
| |
| 6. Employment and Opportunities |
| |
| 7. Commitment to Excellence |
| |

Enhanced Focus: Electrical Derivation and Integral Applications

Skills Development Through Qualifications

Centre Approval Process

Accessible Learning Resources

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| |
| Research and Development |
| |
| Employment and Opportunities |
| |
| Commitment to Excellence |
| |
| 1. Support for Students and Staff |
| |
| 2. Courses and Learning Plans |

| |
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| |
| 3. Equalities and Accessibility Training |
| |
| 4. Specialized Staff Development |
| |
| 5. Accessible Learning Tools |
| |
| 6. Assessment and Exam Guidance |
| |

7. SQA’s Commitment to Excellence

Core Training Programs

Equalities and Inclusivity

Specialized Staff Roles

Technical and Operational Support

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| Podcasts and Learning on the Go |
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| Equal Opportunities and Accessibility |
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| Qualifications Development |
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| Key Highlights for SQA Staff |
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| Course Overview |
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Mandatory Units (Total: 21 SCQF Credit Points)

Optional Units (Choice of 1, Total: 3 SCQF Credit Points)

Recommended Entry

Progression Opportunities

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| Core Skills Certification |
| |
| Alignment with National Occupational Standards (NOS) |
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| Learning and Assessment Approach |
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| Equality and Inclusion |

. Introduction to the Awards

2. Rationale for Revisions

3. History and Market Research

4. Aims of the Awards

5. Qualification Structure

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| 6. Delivery and Assessment Approaches |
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| 7. Guidance for Centres |
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| Integrating Calculations and Derivations into the HNC/HND Structure |

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| 2. Scope and Framework for Revisions |
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| 3. Enhancing Learning with Market Trends |
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| 4. Aims of the Awards with Mathematical Applications |

5. Qualification Structure with Technical Focus

6. Delivery and Assessment Approaches

7. Guidance for Centres

8. Articulation Arrangements

1. Introduction: Advanced Mathematics in Electrical Engineering

2. Scope and Framework Applications

3. Integrating Market Trends

4. Mathematical Applications Aligned with Aims

5. Structuring Mathematical Concepts

6. Practical Delivery and Assessment

7. Support for Centres

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tshingombe, your Personality Test results are in!

Alison Learning <noreply@us-learning.alison.com>

Unsubscribe

Your Numeric Reasoning Test results are in, tshingombe!

Alison Learning <noreply@us-learning.alison.com>

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On Thu, Apr 3, 2025 at 10:41 AM tshingombe fiston <tshingombefiston@gmail.com> wrote:

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Derived Equations in Engineering Training

Experimental Topics Using Calculations

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2. Sizing Electrical Wires

3. Power Capacity in Conductive Materials

4. Heat Dissipation in Electrical Components

5. Configuring Electrical Load for Safety

6. Optimizing Conductive Material for Renewable Systems

Experimental Applications

Bibliographic Overview: Calculating and Sizing Power Systems

Educational and Developmental Entities

Industrial and Technological Contributions

Experimental Topics Related to Power Calculations

Partial Scholarship Application at AIU

Roberto Aldrett - AIU

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My Details

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City Power Johannesburg

City Power Johannesburg

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City Power Johannesburg

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| RegionB Revenue |
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| RegionB Revenue |
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<tshingombefiston@gmail.com>

City Power

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Corruption

Load shedding

Electricity procurement

Revenue recuperation

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Fossil-fuelled power stations

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Zimbabwe Power Exports

Power shortage: 2007 - ongoing

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Transposition

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| Medium line |
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| Heat recovery steam generators |
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| Cogeneration using biomass |
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Power cogeneration in the sugar and alcohol sector

Advantages of the cogeneration using sugarcane bagasse

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Blackout inevitability and electric sustainability

Self-organized criticality

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Mitigation of power outage frequency

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| Smart meters used as a gateway for water and gas meters |
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| Electricity generation and GDP |
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| Electricity consumption by sector |
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| Electricity outlook |
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| Update Regarding Your Application |
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| Eaton TalentHub |
| |
| Thank you for choosing Eaton UPS<br>Service Level Agreement |
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| Eaton<br><MarketingAfrica@eaton.com> |

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My profile

| |
|---|
| Contact details |
| |
| Current access |
| |
| Learning & Development Resources |
| |
| HR Capabilities |
| |
| Functional Technical Training |
| |
| Additional HR Learning |
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| DIGITAL LEARNING CENTER |
| |

Eaton's Digital Foundation

Digital Mindset

Plan your Development

Top News

Virtual Classroom Training in My Region

Classroom Training in My Country

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| All Learning Catalog |
| |
| Instructions |
| |
| Training Schedule |
| |
| Completion Notification for Eaton's Low-Voltage Switchgear |
| |
| eetraining@eaton.com |
| |

| |
|---|
| Completion Status for Eaton Electrical - SEM + Addendum |
| |
| eatonuniversityalerts@eaton.com |
| |

Completion notification and survey for Sales Training Exam: How to Sell More Cables and Connectivity

eatonuniversityalerts@eaton.com

Completion notification and survey for Sales Training Exam: How to Sell More Cables and Connectivity

eatonuniversityalerts@eaton.com

Registration confirmation for Assessing Talent (LeaderX Talent Review Webinars) For EMEA

eatonuniversityalerts@eaton.com

Completion notification and survey for Surge Solutions

eatonuniversityalerts@eaton.com

Registration confirmation for Arc Flash Hazards Assessment and Protection Device Coordination Webinar

eatonuniversityalerts@eaton.com

Registration confirmation for Power press Training Module 1 - PPE & Housekeeping

eatonuniversityalerts@eaton.com

Registration confirmation for Power press Training Module 1 - PPE & Housekeeping

eatonuniversityalerts@eaton.com

Completion notification and survey for Functional Skills Workshop: Human Resources [eLearning]

| |
|---|
| eatonuniversityalerts@eaton.com |
| |
| Build a data center that fits your business needs |
| |

Design, build and operate more sustainable data centers

Reduce risk with safety and security built in

Scale easier and get to market faster

Lower costs, increase revenue and ensure always-on reliability

Knowledge center

| |
|---|
| Filters |
| |
| Configure. Review. Complete. Order. |
| |
| Flexible energy systems will power the future |
| |
| The transition to renewable power |
| |
| Planning for the shift to more electrical power |
| |
| Embracing the new power paradigm |

Unlock the energy transition for your building

Responding to the high demand for low carbon

| |
|---|
| Find out more about Eaton’s global sustainability commitments, including carbon neutrality by 2030 |
| |
| Adapting to fast-changing regulations |
| |
| Ensuring cybersecurity throughout the transition |

Powering the energy transition

Filters

My Career Account

Options

Submissions

| |
|---|
| o Participates in the programming of the project with the customer or customer representative to understand and document the owner's project requirements. Influence on solution to drive. |
| |
| o Understand the codes and ordinances local to the opportunity/project. |

o Solutions Development: Provide appropriate design documents to support the proposal and allow the estimating team to assemble cost for the proposal. These design documents should identify at a minimum the following as applicable:

| |
|---|
| · Identification of major infrastructure equipment |
| |
| · Bid specifications for the major/long lead equipments. |
| |
| · Space, clearances and site layout. |
| |

· Systems diagrams, grounding, calculations, ventilation, gas exhaust, protection relays, others.

· Design Phase:

o Perform code analysis for the project.

| |
|---|
| o Take the lead for the basis of design for the project, including redundancy requirements, detailed design, detailed calculations, validate product selection, etc. |
| |

| |
|---|
| o Engineering support function, supporting requests from other engineering teams, factory, commisiong, sub-contractors, services, site support. |
| |
| o Support on System sequence of operation (SOO) |
| |

| |
|---|
| o Contributes to team effort by accomplishing related results as needed. |
| |
| · Construction Phase: |
| |

| |
|---|
| o Maintains professional and technical knowledge by attending educational workshops; reviewing professional publications; establishing personal networks; participating in professional societies. |
| |
| o Attend new products trainings and events to improve knowledge and capabilities. |

o Prepare and schedule trainings as a SME (Subject Matter Expert) to other engineers

o Social media, internal networking, ability to work in internations environment. Teamwork skills.

| |
|---|
| o Being familiar with a variety of the field´s concepts, practices and procedures. |
| |
| o Travel to customer sites experiencing issues to support the technical resolution . |
| |
| o Participate in Offer Safety related meetings. |
| |

| |
|---|
| o Good English speaking, written and verbal skills. |
| |
| o Good Spanish speaking, written and verbal skills. |
| |
| o Good Communication skills |
| |
| o Good capability to work in a Multi Discipline Engineering team |
| |

o Good acknowledge on Schneider Medium Voltage portfolio.

o Good acknowledge on medium voltage products and safety standards.

o Good capability to work with Microsoft tools, REVIT & CAD.

| |
|---|
| o 5 years of experience in MV Power Systems Design. |
| |
| o Data Center design experience. |
| |
| o Experience on simulation tools such as ETAP or Caneco HT. |
| |
| o MV/LV coordination, arc flash gassing simulation / study. |
| |

| |
|---|
| o Knowledge on Protective relays configuration. |
| |
| o Background in LV power designs. |
| |
| Qualifications |
| |
| Primary Location |
| |
| Other Locations |
| |
| Profile |
| |
| All Notifications |
| |
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| |
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Low Voltage solutions for Commercial and Industrial Buildings

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Enjoy your time!

Industrial Automation market solutions

Find new business opportunities in Industrial Automation Market — skill up starting today

Secure Power solutions for data centers, critical power infrastructure and small offices

Gain new knowledge about Secure Power solutions

Digital Power solutions to increase energy efficiency

Basic Power Metering

Gateways and Energy Servers

Power Quality and Power Factor Correction

Protection Relays

Sustainability School

Gain sustainability knowledge and skills

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| Chapter 1: Gain knowledge |
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| Learn more about mySchneider functionalities |
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| Partner APIs |
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| Improve safety & efficiency, maintain & digitize your current system, reduce your carbon footprint & safeguard against disruptions. |
| |

Improve safety and efficiency, maintain and digitize your current system, reduce your carbon footprint and safeguard against disruptions.

EcoConsult Services Portfolio

EcoConsult Audit

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| EcoConsult Electrical Digital Twin |
| |
| EcoConsult System Studies |
| |
| EcoConsult Design |
| |
| EcoConsult Audit |
| |

EcoConsult Audit for Power

EcoConsult Audit for Power Quality

EcoConsult Audit for Power Monitoring

EcoConsult Audit for Energy Efficiency

EcoConsult Audit for Industrial Automation

EcoConsult Audit for Data Center

EcoConsult Electrical Digital Twin

EcoConsult System Studies

Short Circuit Analysis

Protection Coordination Study

Arc Flash Study

Other Studies

Project Builder

My Preferences

My Courses: Tshingombe fiston

Search Results (134)

EcoXpert Smart Grid, Technical, Intermediate: Geographic Information Systems Path

Test - Basic Machines with PacDrive 3 [VILT] (Test)

Machine Solutions: Basic Machines
PacDrive 3 VILT (Test)

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Question 15 of 15.

Cybersecurity Training für Schneider Electric Service Partner

Description

EBO 2023: Engineering EasyLogic

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Active Training: Tshingombe fiston

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| |
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| Sustainability School: Training you for success |
| |
| Everything you need to know to thrive in the New Electric World |
| Turn your climate ambition into action |
| |
| Chapter 1 courses – two levels! |
| |

| |
|---|
| FUNDAMENTAL-LEVEL |
| |
| ADVANCED-LEVEL |
| |
| Chapter 2: Take action! |
| |
| Available Q2 2023! |
| |
| Chapter 3: Win business! |
| |
| Available Q1 2024! |
| |

Discover EcoStruxure Building Operation Software

Turn system data into actionable insights

Benefits of EcoStruxure Building Operation Software

Flexibility

Open integration

Simple to upgrade

Cybersecurity

Features

Further explore EcoStruxure Building Operation Software

Delivering value to every stakeholder

See what our customers say about
EcoStruxure Building Operation

Aspiria

Resorts World

UST

University of Nottingham

Additional resources

Explore the EcoStruxure Building Operation BMS

Discover Buildings of the Future

White Paper: Assessing the “openness” of a BMS

White Paper: Three elements of next generation BMS

View our portfolio of Smart Building solutions

Discover EcoStruxure Building Operation Software

Turn system data into actionable insights

| |
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| Benefits of EcoStruxure Building Operation Software |
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| Flexibility |
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| Open integration |
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| Simple to upgrade |
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| Cybersecurity |
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Further explore EcoStruxure Building Operation Software

Delivering value to every stakeholder

See what our customers say about EcoStruxure Building Operation

Aspiria

Resorts World

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| UST |
| |
| University of Nottingham |
| |
| Additional resources |
| |
| Explore the EcoStruxure Building Operation BMS |
| |

Discover Buildings of the Future

White Paper: Assessing the "openness" of a BMS

White Paper: Three elements of next generation BMS

View our portfolio of Smart Building solutions

Bill of materials

Bill of materials

Bill of materials

Bill of Material - My Configuration - 6b546e9d-8a2e-424f-af3c-939ea886fdcd - Schneider Electric

Bill of Material - My Configuration - 577e9790-a49e-4c0c-9307-f56f18a5ab60 - Schneider Electric

Bill of Material - My Configuration - f9d295b2-90b2-4164-b665-04551a1f2f54 - Schneider Electric

Bill of Material - My Configuration - dc5b40a4-bb0a-4e45-b277-b7fa55863d6a - Schneider Electric

Bill of materials

Bill of Material - My Configuration - 98d8730c-cef0-4fd3-8fbe-b6f8b3c1d66b - Schneider Electric

Bill of Material - My Configuration - 96d5a340-770b-4927-bab7-5c538288d832 - Schneider Electric

Bill of Material - My Configuration - 36455ef8-f6c2-460a-91c3-15d69cf9452f - Schneider Electric

Bill of Material - My Configuration - 9988cbd9-4fe8-473c-927f-c3473aaf67af - Schneider Electric

Profile

Your Information

My Documents

CPD Pre-Validated Activities

SAQA

What's the Difference Between a Diploma vs a Degree? - Alison

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| [What is NQF Level 4? Key to Secondary Education in SA] |
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| Application for Exemption Terms of Section 23(6) |
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| Particulars of Appellant: |
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| Complaints Management Process: |
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| Security Equipment Definition: |
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| Improper Conduct: |
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| Complaint Resolution: |
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| Job Career Information: |
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| Legal and Administrative Actions: |
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| Expression of Interest and Withdrawals: |
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EN0202272ID

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My Stats

My Projects

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GREEN Power Electronics & Energy

Bonus Content

Categories

Latest News

Solar and Wind Energy

Wind Power: Wise Move or Waste of Time?

Balcony Power Plant: DIY Solar Balcony
= Speedy Payback!

Solar Power Made Simple: Solar
Charging With and Without a Controller

Optimizing Balcony Power Plants: Considerations, Interesting Facts, and Calculations

Batteries

The Road to Battery Power: The Dawn of the Age of Electric Vehicles

ABC of Rechargeable Batteries: Basics, Pitfalls & Recommendations

Safety in Large Lithium Battery Installations

Solar Cell Battery Charger/Monitor

Lithium Battery Pack Repair: Save Money + More Power!

46307064

Achievements

Introduction to Azure Load Balancer

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| [Enhance your service availability and data locality by using Azure Traffic Manager] |
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[Improve your reliability with modern operations practices: An introduction]

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| [Improve your reliability with modern operations practices: Deployment] |
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| Utilize an Azure OpenAI model to create an app |
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| Explore the Copilot stack |
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| Build your custom agent for Teams |

Explore generative AI with Copilot in Bing

Orchestrate containers on Windows Server using Kubernetes

Run containers on Windows Server

Apply Networking concepts to Windows containers running on Azure Kubernetes Service (AKS) and AKS Hybrid

Apply storage concepts to Windows containers running on Azure Kubernetes Service (AKS) and AKS Hybrid

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| Manage Azure Kubernetes Service on Azure Stack HCI |
| Introduction to Azure Kubernetes Service |
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Introduction to Kubernetes

Deploy and run a containerized web app with Azure App Service

Run Docker containers with Azure Container Instances

Build and store container images with Azure Container Registry

Build a containerized web application with Docker

Create a Holographic Remoting app
to visualize 3D content on HoloLens 2

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| [Integrate Azure Cloud Services to your Unity project on HoloLens 2] |
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Activate spatial audio for your HoloLens 2 application

Add Azure AI services to your mixed reality project

Use Azure Spatial Anchors to anchor objects in the real world

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| [Enable eye tracking and voice commands for objects on the HoloLens 2] |
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| [Getting started with 3D object interaction] |

Place a Mars Rover object in the scene and work with grids and intelligent object tracking

[Introduction to the Mixed Reality Toolkit-Set Up Your Project and Use Hand Interaction]

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| Challenge project - Building an Augmented Reality app for HoloLens 2 |
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| Designing for mixed reality |
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| Introduction to mixed reality |
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| Configure 3D assets for mixed reality in Unity |
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[Build a 3D Scene for mixed reality in Unity]

[Set up a mixed reality project for Azure Digital Twins in Unity]

Connect IoT data to mixed reality
with Azure Digital Twins and Unity

Introduction to Polyglot Notebooks

Create a web UI with ASP.NET Core

Learn the basics of web accessibility

Get started with web development using Visual Studio Code

Publish a web app to Azure with Visual Studio

Create a web API with ASP.NET Core controllers

Work with files and directories in a .NET app

Interactively debug .NET apps with the Visual Studio Code debugger

Create a new .NET project and work with dependencies

Introduction to .NET

Deploy and manage Active Directory Domain Services domain controllers

Manage Microsoft Entra identities

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| Understand Microsoft Entra ID |
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| Evaluate deployment methods |
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| [Get tips and tricks for teaching DP-100: Designing and implementing a data science solution on Azure] |
| |

Learn best practices from Microsoft Technical Trainers

| |
|---|
| Microsoft Learn for Educators<br>preparing for course delivery |
| |

[Get tips and tricks for teaching AZ-104 Microsoft Azure Administrator]

Learn best practices from Microsoft Technical Trainers

Microsoft Learn for Educators course planning

Microsoft Learn for Educators
Course Preparation

Onboard to Microsoft Learn for Educators program

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| [Introduction to Microsoft Learn for Educators program] |
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Microsoft Learn for Educators
student certification

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| [Build a Form Recognizer custom skill for Azure Cognitive Search] |
| |
| [Create a composed Form Recognizer model] |

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| |
| Extract data from forms with Form Recognizer |
| |
| |
| Use prebuilt Form Recognizer models |
| |

Plan an Azure AI Document Intelligence solution

Perform vector search and retrieval in Azure AI Search

Perform search re-ranking with semantic ranking in Azure AI Search

Maintain an Azure AI Search solution

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| [Search data outside the Azure platform in Azure AI Search using Azure Data Factory] |
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| [Build an Azure Machine Learning custom skill for Azure AI Search] |
| |

Implement advanced search features in Azure AI Search

Enrich your data with Azure AI Language

Create a knowledge store with Azure AI Search

Create an Azure AI Search solution

Create a custom skill for Azure AI Search

Get started with Data Activator in Microsoft Fabric

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| Get started with Real-Time Analytics in Microsoft Fabric |
| Administer Microsoft Fabric |
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Create and manage a Power BI deployment pipeline

Load data into a Microsoft Fabric data warehouse

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| [Organize a Fabric lakehouse using medallion architecture design] |
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| Ingest data with Spark and Microsoft Fabric notebooks |
| Detect objects in images |
| |
| Classify images |
| |
| Analyze video |

Read Text in images and documents with the Azure AI Vision Service

Detect, analyze, and recognize faces

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| Image classification with custom Azure AI Vision models |
| |

Enhance teaching and learning with Microsoft Copilot

Equip and support learners with AI tools from Microsoft

Teach cybersecurity concepts with Minecraft Education

Lead forward: Integrate the best strategies from remote, hybrid, and blended learning for school leaders

Build a question answering solution

Analyze text with Azure AI Language

Translate speech with the Azure AI Speech service

Create speech-enabled apps with Azure AI services

Translate text with Azure AI Translator service

Create a custom named entity extraction solution

Create a custom text classification solution

Build a question answering solution

Extract insights from text with the Azure AI Language service

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| Build a conversational language understanding model |
| |
| Custom named entity recognition |
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[Get started with the SharePoint Framework]

[Use Change Notifications and Track Changes with Microsoft Graph]

Access Files with Microsoft Graph

Manage Group Lifecycle with Microsoft Graph

Access User Data from Microsoft Graph

Optimize network traffic with Microsoft Graph

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| [Optimize data usage when using Microsoft Graph with query parameters] |
| |
| [Get started with Microsoft Graph Toolkit] |

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| [Access user photo information by using Microsoft Graph] |
| |

[Configure a JavaScript application to retrieve Microsoft 365 data by using Microsoft Graph]

[What is Microsoft Graph?]

Introduction to Office client customization with add-ins

Introduction to customizing and extending SharePoint

Introduction to building apps for Microsoft Teams

Understand Actionable Messages in Outlook fundamentals

[Automate Microsoft Defender for Cloud Apps with Power Automate]

| |
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| [Discover additional resources for Microsoft Defender for Cloud Apps] |
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| [Configure advanced scenarios in Microsoft Defender for Cloud Apps] |
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Microsoft Defender for Cloud Apps SIEM integration

Leading for equity 101—Prepare your school for equity

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| |
| [Explore identity synchronization] |
| |
| [Manage secure user access in Microsoft 365] |
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Manage synchronized identities

Implement directory synchronization tools

Prepare for identity synchronization to Microsoft 365

Prevent data loss

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| [Analyze your Microsoft 365 workplace data using Microsoft Viva Insights] |
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| [Deploy Microsoft 365 Apps for enterprise] |

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| [Manage tenant health and services in Microsoft 365] |
| |
| [Configure administrative roles in Microsoft 365] |

Capture Web Application Logs with
App Service Diagnostics Logging

Improve incident response with alerting on Azure

Analyze your Azure infrastructure by using Azure Monitor logs

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| | |
| [Write multi-table queries by using Kusto Query Language] | |
| | |

Gain insights from your data by using Kusto Query Language

Write your first query with Kusto Query Language

Explore the fundamentals of data analysis using Kusto Query Language (KQL)

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|---|
| [Generate batch predictions using a deployed model in Microsoft Fabric] |
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| [Train and track machine learning models with MLflow in Microsoft Fabric] |
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Preprocess data with Data Wrangler in Microsoft Fabric

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|---|---|
| [Explore data for data science with notebooks in Microsoft Fabric] | |

Get started with data science in Microsoft Fabric

Get started with data warehouses in Microsoft Fabric

Ingest Data with Dataflows Gen2 in Microsoft Fabric

Use Data Factory pipelines in Microsoft Fabric

Work with Delta Lake tables in Microsoft Fabric

Use Apache Spark in Microsoft Fabric

Get started with lakehouses in Microsoft Fabric

Introduction to end-to-end analytics using Microsoft Fabric

Manage leads with Dynamics 365 Sales

Set up and configure Dynamics 365 Sales

Get started with Dynamics 365 Sales

Analyze images

Automate Power BI solution management

Enforce data permissions for Power BI embedded analytics

Integrate content with Power BI client APIs

Embed Power BI content

Set up permissions to embed Power BI content

Select a Power BI embedded analytics product

Introduction to Power BI embedded analytics

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| [Assess and convert SQL Server databases using the Data Migration Assistant (DMA)] |
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| SQL Server Discovery using the Microsoft Assessment and Planning (MAP) toolkit |
| |
| Introduction to upgrading SQL Server |
| |

Use the SQL Server Query Tuning Assistant

Test and optimize SQL Server databases using the Database Experimentation Assistant (DEA)

Assess SQL Server databases for migration to Azure SQL

Design a SQL Server migration strategy

Migrate SQL workloads to Azure Managed Instances

Migrate SQL Server workloads to Azure SQL Database

Migrate on-premises workloads to Azure

Prepare on-premises workloads for migration to Azure

Design your migration to Azure

Migrate VMware resources on-premises to Azure VMware Solution

Prepare to migrate VMware resources to Azure by deploying Azure VMware Solution

Introduction to Azure VMware Solution

Using Azure NetApp Files with Azure VMware Solution

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|---|---|
| [Secure outbound internet connectivity for Azure VMware Solution] | |

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| [Deploy disaster recovery using VMware Site Recovery Manager and Azure VMware Solution] |
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| Implement business continuity, disaster recovery, and backup for SAP HANA on Azure (Large Instances) |
| |

Monitor and troubleshoot SAP HANA on Azure (Large Instances)

Manage SAP HANA on Azure (Large Instances)

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| | |
| [Implement and deploy SAP HANA on Azure (Large Instances)] | |
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| [Examine backup security licensing and support considerations for SAP HANA on Azure (Large Instances)] |
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| [Plan SAP HANA on Azure (Large Instances) high availability and disaster recovery] |
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Plan SAP HANA on Azure (Large Instances) deployments

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| [Examine SAP HANA on Azure (Large Instances) sample architecture] |
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| Identify SAP HANA on Azure (Large Instances) certified offerings |
| |
| Design data integration |
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Design a data storage solution for relational data

Design a data storage solution for non-relational data

Scope report design requirements

Manage Power BI assets by using Microsoft Purview

Catalog data artifacts by using Microsoft Purview

Discover trusted data using Microsoft Purview

Introduction to Microsoft Purview

Integrate Microsoft Purview and Azure Synapse Analytics

Use Delta Lake in Azure Synapse Analytics

Transform data with Spark in Azure Synapse Analytics

Analyze data with Apache Spark in Azure Synapse Analytics

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|---|
| [Challenge project - Create Microsoft Power Platform solutions] |
| |
| [Design a semantic model in Power BI] |
| |

Choose a Power BI model framework

Describe Power BI Desktop models

Optimize a model for performance in Power BI

Add calculated tables and columns to Power BI Desktop models

[Add measures to Power BI Desktop models]

[Write DAX formulas for Power BI Desktop models]

Clean, transform, and load data in Power BI

Get data in Power BI

Explore data analytics at scale

Understand concepts of data analytics

Explore Azure data services for modern analytics

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|---|---|
| [Secure data and manage users in Azure Synapse serverless SQL pools] | |

Create a lake database in Azure Synapse Analytics

Use Azure Synapse serverless SQL pools to transform data in a data lake

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| [Use Azure Synapse serverless SQL pool to query files in a data lake] |
| |
| [Load data into a relational data warehouse] |

Analyze data in a relational data warehouse

Secure a data warehouse in Azure Synapse Analytics

Manage and monitor data warehouse activities in Azure Synapse Analytics

Design a Modern Data Warehouse using Azure Synapse Analytics

Explore Azure Synapse Studio

Survey the Components of Azure Synapse Analytics

Introduction to Azure Synapse Analytics

Introduction to Azure Data Lake Storage Gen2

Introduction to data engineering on Azure

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| Build a Power Apps component |
| |
| Introduction to Dataverse for developers |
| |
| Extend plug-ins in Power Platform |

Apply basic performance optimization in finance and operations apps

Build workspaces in finance and operations apps

Build reports for finance and operations apps

Create classes in finance and operations apps

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| [Build forms and optimize form performance in finance and operations apps] |
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Build data models in finance and operations apps

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| [Build extended data types and enumerations for finance and operations apps] |
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Develop object-oriented code in finance and operations apps

[Get started with development using X++ in finance and operations apps]

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| [Start developing for finance and operations apps by using Visual Studio] |
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| [Set up a VHD for finance and operations apps] |
| |
| [Configure Azure App Service] |
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| [Configure Azure App Service plans] |

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| Configure virtual machine availability |
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| Configure virtual machines |
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Host a web application with Azure App Service

Manage virtual machines with the Azure CLI

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| Configure Azure Container Instances |
| |
| Enable Containers security |
| |
| Configure and manage host security |
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| Configure network security |
| |
| Implement perimeter security |
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| Microsoft Accessibility Features and Tools |
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| Introduction to disability and accessibility |
| |
| Digital accessibility |
| |

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| Creating accessible content with Microsoft 365 |
| |
| Introduction to Teams Meetings |
| |

Bringing it all together for engaging virtual events in Microsoft 365

Design a successful virtual event using Microsoft 365

[Introduction to delivering virtual events using Microsoft Teams and Microsoft 365]

Introduction to collaborating with Microsoft Teams

Facilitate meetings and events with Microsoft Teams

Collaborate in teams and channels
with Microsoft Teams

[Create and manage teams and channels with Microsoft Teams]

Describe support offerings for Microsoft 365 services

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| Describe Microsoft 365 pricing, licensing, and billing options |
| |
| Explore Azure Functions |
| |
| Develop Azure Functions |

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| [Make recommendations with Azure AI Personalizer] | |
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| [Classify and moderate text with Azure Content Moderator] | |

Support reading fluency practice with Reading Progress

Introduction to Azure Logic Apps

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| [Create and deploy an Azure Logic Apps workflow using Azure Resource Manager templates] |
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| [Call an API from an Azure Logic Apps workflow using a custom connector] |
| |

Route and process data automatically using Azure Logic Apps

Create serverless logic with Azure Functions

Expose hybrid services securely with Azure Relay

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| [Implement message-based communication workflows with Azure Service Bus] |
| |

[Choose a messaging model in Azure to loosely connect your services]

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| [React to state changes in your Azure services by using Event Grid] | |

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| [Enable reliable messaging for Big Data applications using Azure Event Hubs] |
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| [Communicate between applications with Azure Queue storage] |
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| [Work with Azure Blob storage] |
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Manage the Azure Blob storage lifecycle

Explore Azure Blob storage

Explore Azure App Service deployment slots

Scale apps in Azure App Service

Configure web app settings

Explore Azure App Service

Design a solution for backup and disaster recovery

Describe high availability and disaster recovery strategies

Implement canary releases and dark launching

Implement blue-green deployment and feature toggles

Introduction to deployment patterns

Manage application configuration data

Integrate with identity management systems

Implement A/B testing and progressive exposure deployment

Manage alerts, blameless retrospectives and a just culture

Design processes to automate application analytics

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| Share knowledge within teams |
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| Develop monitor and status dashboards |
| |

Implement tools to track usage and flow

Manage Git repositories

Plan foster inner source

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| Explore Git hooks |
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| Identify technical debt |
| |
| Collaborate with pull requests in Azure Repos |
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| Manage Git branches and workflows |
| |
| Structure your Git Repo |
| |
| Introduction to data protection and privacy |

Discover the potential of Azure for government

Support data classification with private and hybrid clouds

Safeguard public sector data with Azure

[Describe the identity protection and governance capabilities of Microsoft Entra]

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| Describe access management capabilities of Microsoft Entra ID |
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| Describe the authentication capabilities of Microsoft Entra ID |
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| Describe the function and identity types of Microsoft Entra ID |
| |
| Describe identity concepts |
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Describe security and compliance concepts

Describe analytics capabilities of Microsoft 365

[Describe endpoint modernization, management concepts, and deployment options in Microsoft 365]

Describe collaboration solutions of Microsoft 365

Describe productivity solutions of Microsoft 365

What is Microsoft 365?

Use Azure AI Services for Language in a Microsoft Copilot Studio bot

[Set up a Microsoft Copilot Studio bot for voice]

[Manage Power Virtual Agents]

Build effective bots with Microsoft Copilot Studio

Enhance Microsoft Copilot Studio bots

[Work with entities and variables in Microsoft Copilot Studio]

[Manage topics in Microsoft Copilot Studio]

Get started with Microsoft Copilot Studio bots

Create calculation groups

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| [Use DAX time intelligence functions in Power BI Desktop models] |
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| [Create Power BI model relationships] |
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| Use tools to optimize Power BI performance |
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| Enforce Power BI model security |
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| Publish and share in Power BI |

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| Explore data in Power BI |
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| Use visuals in Power BI |
| |
| Model data in Power BI |
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Get started building with Power BI

Discover data analysis

Operate a guide in Dynamics 365 Guides

[Author a guide in Dynamics 365 Guides]

[Dynamics 365 Guides for administrators]

Get started with Dynamics 365 Guides

Embed 21st century skills with 21st century learning design

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| Deepen educational experiences with the 21CLD ICT for learning dimension |
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Develop learner executive function with the 21CLD self-regulation dimension

Improve communication skills with the 21CLD skilled communication dimension

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| Innovate learning with the 21CLD real-world problem solving and innovation dimension |
| |

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| [Practice collaborative skills with the 21CLD collaboration dimension] |
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Develop critical thinking skills with the 21CLD knowledge construction dimension

Transform learning with 21st century learning design

[Set up number series and trail codes in Dynamics 365 Business Central]

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| [Set up general ledger configuration options in Dynamics 365 Business Central] |
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| [Set up inventory replenishment in Dynamics 365 Business Central] |
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| [Plan items in Dynamics 365 Business Central] |

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| [Set up inventory planning in Dynamics 365 Business Central] |
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Demand Driven Material
Requirements Planning in Dynamics
365 Supply Chain Management

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| [Use master planning in Dynamics 365 Supply Chain Management] |
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| [Set up Master Planning in Dynamics 365 Supply Chain Management] |
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[Create bill of materials in Dynamics 365 Supply Chain Management]

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| [Create products and product masters in Dynamics 365 Supply Chain Management] |
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| [Use inventory reports in Dynamics 365 Supply Chain Management] |
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| [Configure and work with inventory management in Dynamics 365 Supply Chain Management] |
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| [Get started with Dynamics 365 Supply Chain Management] |
| [Introduction to scripting in PowerShell] |
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| Write your first PowerShell code |
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| Connect commands into a pipeline |
| |
| Discover commands in PowerShell |
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| Introduction to PowerShell |
| |
| Write your first program in C++ |
| Create a Bot with the Bot Framework Composer |

[Create a bot with the Bot Framework SDK]

[Deploy Azure AI services in containers]

Monitor Azure AI services

Secure Azure AI services

Create and consume Azure AI services

Prepare to develop AI solutions on Azure

Understand the MySQL storage engine

Understand client-server communication in MySQL

Explore MySQL Architecture

Understand concurrency in MySQL

Secure MySQL

Beneath the surface: Device details for IT administrators

Analyze DevOps Continuous Planning and Continuous Integration

Route system feedback to development teams

Explain DevOps Continuous Delivery and Continuous Quality

Characterize DevOps Continuous Collaboration and Continuous Improvement

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| Introduce the foundation pillars of DevOps: Culture and Lean Product |
| |

Assess your existing software development process

Manage Agile software delivery plans across teams

Choose an Agile approach to software development

Introduction to Azure DevOps

Introduction to Git

Edit code through branching and merging in Git

Collaborate with Git

How to create and modify a Git project

Enhance creativity to advance learning with Windows 11 and Microsoft 365 tools

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| Increase productivity with Office, OneNote, and Edge browser in Windows 11 |
| |
| Build community with Teams and OneNote |

Transition to and prepare for fundamentals-level security, compliance, and identity course

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| Develop search strategies with<br>Search Coach and Search Progress |
| |

[Perform hyperparameter tuning with Azure Machine Learning]

[Track model training with MLflow in jobs]

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| [Run a training script as a command job in Azure Machine Learning] |
| |
| [Deploy a model to a batch endpoint] |
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Deploy a model to a managed online endpoint

Run pipelines in Azure Machine Learning

Find the best classification model
with Automated Machine Learning

Make data available in Azure Machine Learning

Build a machine learning model

Data collection and manipulation

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| [Introduction to rocket launches] |
| |
| [Digital citizenship: Prepare today's learners for online success] |
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Extract invoice data with AI Builder's prebuilt model

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| Automate the processing of documents with the AI Builder prepackaged solution |
| |
| Manage models in AI Builder |
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| Get started with AI Builder |
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| Use text generation in AI Builder |
| |
| Introduction to expressions in Power Automate |

[Upload, download, and manage data with Azure Storage Explorer]

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| [Control access to Azure Storage with shared access signatures] |
| |
| [Configure Azure Storage with tools] |
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| | [Configure Azure Files and Azure File Sync] |
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| | [Configure Azure Storage security] |
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Find commands and Get-Help in Windows PowerShell

Understand the command syntax in Windows PowerShell

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| Review Windows PowerShell |
| |
| Manage mail flow rules |
| |
| Troubleshoot mail flow |
| |
| Manage mail flow |
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[Troubleshoot audio, video, and client issues]

[Configure auto attendants and call queues]

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| Configure and manage voice users |
| |
| Configure and deploy Teams Phone |
| |
| Plan for Teams Phone |
| |

Configure, deploy, and manage Teams devices

Plan for Microsoft Teams Rooms and Surface Hub

Manage meetings and events experiences

Introduction to Teams meetings and calling

Monitor your Microsoft Teams environment

Implement lifecycle management and governance for Microsoft Teams

Plan and deploy Microsoft Teams

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| Explore Microsoft Teams |
| |
| Examine Azure Identity Protection |
| |
| Examine Privileged Identity Management |
| |

Examine Microsoft Secure Score

Explore security solutions in Microsoft 365 Defender

Explore the Zero Trust security model

Examine threat vectors and data breaches

[Use OneDrive in Microsoft 365]

[Configure client connectivity to Microsoft 365]

[Add a custom domain in Microsoft 365]

[Manage groups in Microsoft 365]

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| [Manage users, licenses, and mail contacts in Microsoft 365] |
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| [Configure your Microsoft 365 experience] |

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| Implement compliance for Microsoft Teams |
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| Implement security for Microsoft Teams |
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Manage access for external users

Plan and configure network settings for Microsoft Teams

Support social and emotional learning with Microsoft tools

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| Keep students engaged: Build strong student/teacher connections in a remote learning environment |
| |

Stay connected with remote learning through Microsoft Teams and Office 365

Hybrid learning in the primary classroom

Hybrid learning: A new model for the future of learning

Hybrid learning for the adolescent learner

Hybrid learning in the intermediate classroom

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| Accessibility, special education, and online learning: Supporting equity in a remote learning environment |
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| Differentiation in the classroom using the built-in tools in Office 365 and Windows |
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| Simplify cloud procurement and governance with Azure Marketplace |
| |
| Design a program launch strategy |
| |

Prepare for a program approval event

Design degree program curricula that implement certification

Define academic and industry requirements for implementing certifications in degree programs

[Work with data source limits (delegation limits) in a Power Apps canvas app]

Work with relational data in a Power Apps canvas app

Use custom connectors in a Power Apps canvas app

Connect to other data in a Power Apps canvas app

[Use and understand Controls in a canvas app in Power Apps]

[Document and test your Power Apps application]

[Build a mobile-optimized app from Power Apps]

[Manage apps in Power Apps]

[Navigation in a canvas app in Power Apps]

[How to build the UI in a canvas app in Power Apps]

[Customize a canvas app in Power Apps]

[Get started with Power Apps canvas apps]

[How to build your first model-driven app with Dataverse]

[Configure forms, charts, and dashboards in model-driven apps]

[Get started with model-driven apps in Power Apps]

Create tables in Dataverse

Validation of Teams apps extensible across Microsoft 365

Add significant value to your Teams app

Publish Teams apps in Microsoft Teams store

Azure Health Bot built-in scenarios

Language understanding in Azure Health Bot

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| Azure Health Bot case studies |
| |
| Basic Azure Health Bot |
| Introduction to Azure Health Bot |
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Channelized Azure Health Bot

Integrate Azure Health Bot with a database

Enhanced Azure Health Bot

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| Azure Health Bot scenario templates |
| |
| Deploy a customer service bot |
| |

Create a chatbot to help students learn geography

Introduction to responsible bots

Detect objects in images with Azure AI Custom Vision

Translate text and speech with Azure AI services

Classify images with Azure AI Custom Vision

Challenge project - Add image analysis and generation capabilities to your application

Challenge project - Work with variable data in C#

Guided project - Work with variable data in C#

[Modify the content of strings using built-in string data type methods in C#]

Format alphanumeric data for presentation in C#

Perform operations on arrays using helper methods in C#

Convert data types using casting and conversion techniques in C#

Choose the correct data type in your C# code

Challenge project - Create a mini-game

Guided project - Plan a Petting Zoo Visit

Create C# methods that return values

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| Create C# methods with parameters |
| |
| Write your first C# method |
| |

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| [Challenge project - Debug a C# console application using Visual Studio Code] |
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| [Guided project - Debug and handle exceptions in a C# console application using Visual Studio Code] |
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Create and throw exceptions in C# console applications

Implement exception handling in C# console applications

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| Implement the Visual Studio Code debugging tools for C# |
| |

Review the principles of code debugging and exception handling

Evaluate Boolean expressions to make decisions in C#

Challenge project - Develop branching and looping structures in C#

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| [Guided project - Develop conditional branching and looping structures in C#] |
| |

Add looping logic to your code using the do-while and while statements in C#

Iterate through a code block using for statement in C#

Control variable scope and logic using code blocks in C#

Branch the flow of code using the switch-case construct in C#

Get started with Jupyter notebooks for Python

Python error handling

Python functions

Manage data with Python dictionaries

Use 'while' and 'for' loops in Python

Introduction to lists in Python

Use mathematical operations in Python

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| Use strings in Python |
| |
| Use Boolean logic in Python |
| |
| Create and manage projects in Python |
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Write your first Python programs

Get started with Python in Visual Studio Code

Using GitHub Copilot with Python

Using GitHub Copilot with JavaScript

Introduction to GitHub Copilot for Business

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| Introduction to GitHub Copilot |
| |
| Deploy a model with GitHub Actions |
| |
| Work with environments in GitHub Actions |

Work with linting and unit testing in GitHub Actions

Trigger GitHub Actions with feature-based development

Trigger Azure Machine Learning jobs with GitHub Actions

Use an Azure Machine Learning job for automation

Train and evaluate regression models

Explore and analyze data with Python

Train and evaluate deep learning models

Train and evaluate clustering models

Train and evaluate classification models

Measure and optimize model performance with ROC and AUC

Confusion matrix and data imbalances

Select and customize architectures and hyperparameters using random forest

Create and understand classification models in machine learning

Refine and test machine learning models

Train and understand regression models in machine learning

Introduction to data for machine learning

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| Build classical machine learning models with supervised learning |
| |
| Introduction to machine learning |
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| [Create a clustering model with Azure Machine Learning designer](#) |
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[Create a classification model with Azure Machine Learning designer]

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| [Create a regression model with Azure Machine Learning designer] |
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| [Use Automated Machine Learning in Azure Machine Learning] |
| |
| [Explore developer tools for workspace interaction] |

Explore Azure Machine Learning workspace resources and assets

Explore Azure Storage for non-relational data

Explore fundamentals of Azure Cosmos DB

Explore relational database services in Azure

Explore fundamental relational data concepts

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| Fundamentals of Azure AI services |
| |
| Fundamentals of machine learning |
| |
| Fundamental AI Concepts |
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| Fundamentals of Knowledge Mining with Azure Cognitive Search |
| |
| Fundamentals of Azure AI Document Intelligence |

Introduction to Computer Vision with PyTorch

Introduction to PyTorch

Introduction to audio classification with PyTorch

Introduction to Natural Language Processing with PyTorch

Transcribe large amounts of audio data with Batch Transcription

Fundamentals of optical character recognition

Fundamentals of Facial Recognition

Fundamentals of Computer Vision

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|---|
| [Introduction to Azure Bot Service and Bot Framework Composer] |
| |

[Fundamentals of question answering with the Language Service]

Fundamentals of Text Analysis with the Language Service

Fundamentals of Azure AI Speech

Fundamentals of conversational language understanding

Use your own data with Azure OpenAI Service

Generate images with Azure OpenAI Service

Generate code with Azure OpenAI Service

Apply prompt engineering with
Azure OpenAI Service

Build natural language solutions with Azure OpenAI Service

Get started with Azure OpenAI Service

Fundamentals of Responsible Generative AI

Fundamentals of Azure OpenAI Service

Fundamentals of Generative AI

Describe monitoring tools in Azure

Describe features and tools for managing and deploying Azure resources

Describe features and tools in Azure for governance and compliance

Describe cost management in Azure

Align requirements with cloud types and service models in Azure

Move Azure resources to another resource group

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| [Control and organize Azure resources with Azure Resource Manager] |
| |

[Create custom roles for Azure resources with role-based access control (RBAC)]

Manage access to an Azure subscription by using Azure role-based access control (Azure RBAC)

Secure your Azure resources with Azure role-based access control (Azure RBAC)

Create Azure users and groups in Microsoft Entra ID

Configure role-based access control

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| Configure Azure Policy |
| |
| Configure subscriptions |
| |
| Configure user and group accounts |
| |

Configure Microsoft Entra ID

Allow users to reset their password with Microsoft Entra self-service password reset

[Manage device identity with Microsoft Entra join and Enterprise State Roaming]

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| Secure Microsoft Entra users with multifactor authentication |
| |
| Implement and manage hybrid identity |
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Implement and manage external identities

Create, configure, and manage identities

Implement initial configuration of Microsoft Entra ID

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| Investigate threats by using audit features in Microsoft 365 Defender and Microsoft Purview Standard |
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| Manage insider risk in Microsoft Purview |

[Respond to data loss prevention alerts using Microsoft 365]

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| Utilize Vulnerability Management in Microsoft Defender for Endpoint |
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| [Configure for alerts and detections in Microsoft Defender for Endpoint] |
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| [Configure and manage automation using Microsoft Defender for Endpoint] |
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| [Perform evidence and entities investigations using Microsoft Defender for Endpoint] |
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| [Perform actions on a device using Microsoft Defender for Endpoint] |
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| [Perform device investigations in Microsoft Defender for Endpoint] |
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| Implement Windows security enhancements with Microsoft Defender for Endpoint |
| |

Deploy the Microsoft Defender for Endpoint environment

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| [Protect against threats with Microsoft Defender for Endpoint] |
| |

Challenge project - Develop foreach and if-elseif-else structures to process array data in C#

Guided project - Develop foreach and if-elseif-else structures to process array data in C#

Create readable code with conventions, whitespace, and comments in C#

Store and iterate through sequences of data using Arrays and the foreach statement in C#

Add decision logic to your code using `if`, `else`, and `else if` statements in C#

Call methods from the .NET Class Library using C#

Install and configure Visual Studio Code

Perform basic string formatting in C#

Store and retrieve data using literal and variable values in C#

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| Write your first C# code |
| |
| Guided project - Calculate final GPA |
| |
| Guided project - Calculate and print student grades |

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| |
| Perform basic operations on numbers in C# |
| |
| |
| Explore Windows Editions |
| |
| |
| Explore the Enterprise Desktop |

Examine data security and compliance in Microsoft 365 Copilot

Implement Microsoft 365 Copilot

Examine the Microsoft 365 Copilot design

Manage records in Microsoft Purview

Manage data retention in Microsoft 365 workloads

Manage the data lifecycle in Microsoft Purview

| |
|---|
| [Configure DLP policies for Microsoft Defender for Cloud Apps and Power Platform] |
| |
| [Prevent data loss in Microsoft Purview] |

Manage data loss prevention policies and reports in Microsoft 365

Apply and manage sensitivity labels

Protect information in Microsoft Purview

Deploy Microsoft Purview Message Encryption

Understand Microsoft 365 encryption

Create and manage sensitive information types

Classify data for protection and governance

Introduction to information protection and data lifecycle management in Microsoft Purview

Design an application architecture

| |
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| Design an Azure compute solution |
| |
| Design migrations |
| |
| Design network solutions |
| |

Design a solution to log and monitor Azure resources

Design authentication and authorization solutions

| |
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| Design governance |
| |
| Save money with Azure Reserved Instances |
| |

[Introduction to analyzing costs and creating budgets with Microsoft Cost Management]

| |
|---|
| [Microsoft Azure Well-Architected Framework - Cost optimization] |
| |

| | |
|---|---|
| [Introduction to the Microsoft Azure Well-Architected Framework] | |

Microsoft Cloud Adoption Framework for Azure

Describe Azure identity, access, and security

Describe Azure storage services

Describe Azure compute and networking services

Describe the core architectural components of Azure

Describe cloud service types

Describe the benefits of using cloud services

Describe cloud computing

Publish an API to Azure Static Web Apps

Publish an Angular, React, Svelte, or Vue JavaScript app with Azure Static Web Apps

| |
|---|
| [Create and publish a static web app with Gatsby and Azure Static Web Apps] |
| |

[Publish a Blazor WebAssembly app and .NET API with Azure Static Web Apps]

Authenticate users with Azure Static Web Apps

Sign in users with Microsoft Entra ID in a Java web app

Accelerate a Spring Boot application with Azure Cache for Redis

| |
|---|
| [Enable asynchronous messaging in Java apps by using JMS and Azure Service Bus] |
| |

Build a Java app with cloud-scale NoSQL Cosmos DB

Deploy a Java EE (Jakarta EE) application to Azure

Deploy Spring microservices to Azure

Store application data with Azure Blob Storage

Secure your Azure Storage account

Connect an app to Azure Storage

Create an Azure Storage account

[Choose a data storage approach in Azure]

[Introduction to Docker containers]

Secure your identities by using Microsoft Entra ID

Automate Azure tasks using scripts with PowerShell

Control Azure services with the CLI

Fundamentals of network security

Fundamentals of computer networking

[Introduction to Azure virtual machines]

[Create a Windows virtual machine in Azure]

[Provisioning a Linux virtual machine in Microsoft Azure]

[Plan your Linux environment in Azure]

Introduction to Linux on Azure

Build and run a web application with the MEAN stack on an Azure Linux virtual machine

| |
|---|
| [Optimizing IT operations and management with Azure Automanage] |
| |
| [Manage hybrid workloads with Azure Arc] |

Administer and manage Windows Server IaaS Virtual Machine remotely

Perform Windows Server secure administration

Perform post-installation configuration of Windows Server

Describe Windows Server administration tools

Implement and manage Active Directory Certificate Services

Manage advanced features of AD DS

Implement Group Policy Objects

Manage AD DS domain controllers and FSMO roles

Introduction to AD DS

| |
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| Deploy and manage Azure IaaS Active Directory domain controllers in Azure |
| |
| Implement hybrid identity with Windows Server |

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| Implement hybrid network infrastructure |
| |
| Implement remote access |
| |
| Implement IP Address Management |

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| Implement Windows Server DNS |
| |
| Deploy and manage DHCP |
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| Implement DNS for Windows Server IaaS VMs |

Implement Windows Server IaaS VM
IP addressing and routing

Implement Windows Server IaaS VM network security

Windows Server update management

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| Hardening Windows Server |
| |
| Secure Windows Server user accounts |
| |
| Secure Windows Server DNS |
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| Implement change tracking and file integrity monitoring for Windows IaaS VMs |
| |

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| [Configure BitLocker disk encryption for Windows IaaS Virtual Machines] |
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| Create and implement application allowlists with adaptive application control |
| |
| Manage Azure updates |
| |

Audit the security of Windows Server IaaS Virtual Machines

Configure and monitor Microsoft Sentinel

Enable and manage Microsoft Defender for Cloud

Configure and manage Azure Monitor

Improve your cloud security posture
with Microsoft Defender for Cloud

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| [Secure your cloud apps and services with Microsoft Defender for Cloud Apps] |
| |

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| [Safeguard your environment with Microsoft Defender for Identity] |
| |

Remediate risks with Microsoft Defender for Office 365

Protect your identities with Microsoft Entra ID Protection

Mitigate incidents using Microsoft 365 Defender

Introduction to Microsoft 365 threat protection

Configure Azure Load Balancer

Configure network routing and endpoints

Configure Azure Virtual Network peering

Configure Azure DNS

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| Configure network security groups |
| |
| Configure virtual networks |
| |

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| [Improve application scalability and resiliency by using Azure Load Balancer] |
| |

Manage and control traffic flow in your Azure deployment with routes

Host your domain on Azure DNS

Distribute your services across Azure virtual networks and integrate them by using virtual network peering

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| Design an IP addressing schema for your Azure deployment |
| |
| Configure Azure Application Gateway |
| |

Design an enterprise governance strategy

Configure Microsoft Entra Privileged Identity Management

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| Deploy Microsoft Entra ID Protection |
| |
| Implement Hybrid identity |
| |

Secure Azure solutions with Microsoft Entra ID

Functional Consultant skills

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| [Use knowledge articles to resolve Dynamics 365 Customer Service cases] |
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| [Search and filter knowledge articles by using Dynamics 365 Customer Service] |
| |

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| [Create knowledge management solutions in Dynamics 365 Customer Service] |
| |

[Translate Dynamics 365 apps and documentation with Dynamics 365 Translation Service]

Challenge project - Architecting solutions for a new product line for customers

Perform fit gap analysis

[Work with requirements for Microsoft Power Platform and Dynamics 365]

| |
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| Propose a solution as a Solution Architect for Microsoft Power Platform and Dynamics 365 |
| |

Discover customer needs as a Solution Architect for Dynamics 365 and Microsoft Power Platform

Becoming a solution architect for Dynamics 365 and Microsoft Power Platform

Integration design for Dynamics 365 solutions

[Review the security model for your Dynamics 365 solutions]

| |
|---|
| [Create a data migration strategy for Dynamics 365 solutions] |
| |
| [Gap solution design for Dynamics 365 solutions] |

Business intelligence and analytics design for Dynamics 365 solutions

Design data models for Dynamics 365 solutions

Plan a testing strategy for your Dynamics 365 solution

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| [Create a solution blueprint for Dynamics 365 solutions] |
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Get started with Success by Design for Dynamics 365

Post go-live strategy for Dynamics 365 solutions

Cutover strategy for Dynamics 365 solutions

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| Implement a performance strategy for Dynamics 365 solutions |
| |

Dual-write implementation for Dynamics 365 solutions

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| Implement common integration features in finance and operations apps |
| |
| Personalize finance and operations apps |

[Work with workflows in finance and operations apps]

[Set up batch jobs in finance and operations apps]

Plan and implement legal entities in finance and operations apps

| |
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| [Plan and configure the global address book in finance and operations apps] |
| |

Feature management in finance and operations apps

Prepare to go-live with finance and operations apps

Implement role-based security in finance and operations apps

Plan and implement security in finance and operations apps

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| [Work with performance and monitoring tools in finance and operations apps] |
| |

Updates and upgrades for finance and operations apps

| |
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| [Design and build mobile apps for finance and operations apps] |
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|---|
| Describe building automation with Microsoft Power Automate |
| |

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| Identify foundational components of Microsoft Power Platform |
| |

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| Describe how to build applications with Microsoft Power Apps |
| |

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| Describe the business value of the Microsoft Power Platform |
| |

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| [Work with analytics and reporting in finance and operations apps] |
| |

Data integrations with finance and operations apps

[Identify data integration patterns and scenarios in finance and operations apps]

Consume business events in finance and operations apps

| |
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| [Explore extensions and the extension framework in finance and operations apps] |
| |

Implement application lifecycle management in finance and operations apps

Prepare data for migration to finance and operations apps

[Work with data management in finance and operations apps]

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| [Perform user acceptance testing in finance and operations apps] | |

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| [Design and plan an implementation of finance and operations apps] | |

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| [Get started with Lifecycle Services for finance and operations apps] |
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| [FastTrack Customer Success Program for finance and operations] |
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| [Get started with a finance and operations implementation project] |
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Use approval workflows in Dynamics 365 Business Central

Create workflows in Dynamics 365 Business Central

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| Migrate on-premises data to Dynamics 365 Business Central |
| |
| Migrate data to Business Central |
| |

Create new companies in Business Central

Administer Dynamics 365 Business Central online

Integrate Business Central with Outlook

Set up email in Dynamics 365 Business Central

Manage users and implement security in Business Central

Administer Microsoft Power Platform subscriptions

Manage Microsoft Power Platform deployments

Use administration options for Dataverse

Get started with security roles in Dataverse

Authentication and user management in Power Pages

Integrate Power Pages with web-based technologies

| |
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| Power Pages administration |
| |
| Power Pages maintenance and troubleshooting |
| |

| |
|---|
| [Run a Power Automate for desktop flow in unattended mode] |
| |
| [Use the Teams connector in Power Automate] |

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| [Use AI Builder to process invoice forms in Power Automate] |
| |

[Integrate desktop flows with Outlook connector in Power Automate for desktop]

| |
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| [Connect a cloud flow to desktop flows in Power Automate for desktop] |
| |

Define input and output parameters in Power Automate

Build your first Power Automate for desktop flow

Optimize your business process with process advisor

Use AI Builder in Power Automate

[Use the Admin center to manage environments and data policies in Power Automate]

| |
|---|
| Power Automate's deep integration across multiple data sources |
| Build flows to manage user information |
| |

Build approval flows with Power Automate

Get started with Power Automate

Get data with Power BI Desktop

Secure, publish, and share data in Power BI

Design interactive data experiences with Power BI Desktop

Transition from Excel to Power BI

Introduction to foundations in data modeling

Automate data cleaning with Power Query

Introduction to modern analytics using Excel and Power BI

Describe the capabilities of Microsoft Power BI

Explore fundamentals of data visualization

Explore fundamentals of real-time analytics

Explore fundamentals of large-scale analytics

Explore data roles and services

Explore core data concepts

Automate multi-container Kubernetes deployments with Azure Pipelines

Automate Docker container deployments with Azure Pipelines

Automate Azure Functions
deployments with Azure Pipelines

| | |
|---|---|
| | [Manage release cadence in Azure Pipelines by using deployment patterns] |
| | |
| | [Run nonfunctional tests in Azure Pipelines] |

Run functional tests in Azure Pipelines

Create a multistage pipeline by using Azure Pipelines

| |
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| [Create a release pipeline in Azure Pipelines] |
| |
| [Host your own build agent in Azure Pipelines] |
| |

Manage build dependencies with Azure Artifacts

Run quality tests in your build pipeline by using Azure Pipelines

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| |
| [Create a build pipeline with Azure Pipelines] |
| |
| [Explore Azure Pipelines] |
| |

Learn continuous integration with GitHub Actions

Introduction to GitHub Actions

Work with Azure Repos and GitHub

Describe types of source control systems

Introduction to source control

| |
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| |
| Plan Agile with GitHub Projects and Azure Boards |
| |
| Choose the DevOps tools |
| |
| Describe team structures |

| |
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| |
| Choose the right project |
| |
| Introduction to DevOps |
| |
| Independent learning with math tools in OneNote |
| |

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| [OneNote Class Notebook: A teacher's all-in-one notebook for students] |
| |

Converse, collaborate, and build community in Teams

| |
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| Organize content, create assignments, and assess learners' understanding in Teams |
| |

Collaborate with colleagues through live Teams meetings and OneNote

Work collaboratively with Staff and PLC Teams

Assemble learners and staff with Microsoft Teams meetings

| |
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| |
| [Explore the benefits of becoming a Microsoft Educator Trainer] |
| |
| [Engage and amplify with Flip] |
| |

OneNote Staff Notebook: Tools for staff collaboration

Digital storytelling with Microsoft Sway

Create authentic assessments with Microsoft Forms

| |
|---|
| [Engage teachers and students with Windows 11 and Windows 11 SE: Course 201] |
| |

| |
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| Empower school leaders and tech-savvy educators with Windows 11 and Windows 11 SE: Course 101 |
| |
| Get started with OneNote |
| |

Flipped instruction with PowerPoint Recorder

Structure Teams through channels, tabs, files, and apps

Empower every student with an inclusive classroom

Accessibility: Build the foundation for inclusive learning

Teach forward: Best strategies for hybrid, remote, and blended learning

Empower educators to explore the potential of artificial intelligence

Products

Roles

Levels

Subjects

anscript

46307064

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| |
| Expand your AI skills based on your role |
| |
| Developer |
| |
| Thank you for your interest in Microsoft! |
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| Thank you for your interest in Microsoft! |
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| nline Training |
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|---|
| Official ISC2 Certified in Cybersecurity (CC) eTextbook |
| |
| Price: $24.95 |
| |
| Language: |
| |
| Who Should Purchase: |
| |
| What to Expect: |
| |
| CPE Credits |
| |
| Access Period: |
| |
| This eTextbook covers the following: |

Chapter 1: Security Principles

Chapter 2: Incident Response, Business Continuity and Disaster Recovery Concepts

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| Chapter 3: Access Controls Concepts |
| |
| Chapter 4: Network Security |
| |
| Chapter 5: Security Operations |
| |
| Technology Requirements: |

Hardware Specifications

Supported Operating Systems

Supported Browsers

Application Software

Certified in Cybersecurity Certification Exam Outline

About Certified in Cybersecurity

Certified in Cybersecurity Examination Information

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| Certified in Cybersecurity Examination Weights |
| |
| Domains |
| |
| 1.1 - Understand the security concepts of information assurance |
| |
| 1.2 - Understand the risk management process |
| |

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| 1.3 - Understand security controls |
| |
| 1.4 - Understand ISC2 Code of Ethics |
| |
| 1.5 - Understand governance processes |
| |
| 2.1 - Understand business continuity (BC) |
| |
| 2.2 - Understand disaster recovery (DR) |

| |
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| |
| 2.3 - Understand incident response |
| |
| 3.1 - Understand physical access controls |
| |
| 3.2 - Understand logical access controls |
| |
| 4.1 - Understand computer networking |
| |

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|---|
| 4.2 - Understand network threats and attacks |
| |
| 4.3 - Understand network security infrastructure |
| |
| 5.1 - Understand data security |
| |
| 5.2 - Understand system hardening |
| |

5.3 - Understand best practice security policies

5.4 - Understand security awareness training

Access Period:

This eTextbook covers the following:

Chapter 1: Security Principles

Chapter 2: Incident Response, Business Continuity and Disaster Recovery Concepts

Chapter 3: Access Controls Concepts

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| |
| Chapter 4: Network Security |
| |
| Chapter 5: Security Operations |
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| |
| Technology Requirements: |
| |
| Hardware Specifications |
| |

Supported Operating Systems

Supported Browsers

Application Software

Online Training

Continuing education

Find an exam

SSCP Certification Exam Outline

About SSCP

Experience Requirements

Accreditation

Job Task Analysis (JTA)

SSCP Examination Information

| |
|---|
| SSCP Examination Weights |
| |
| Domains |
| |
| 1.1 - Comply with codes of ethics |
| |
| 1.2 - Understand security concepts |
| |
| 1.3 - Identify and implement security controls |
| |

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| 1.4 - Document and maintain functional security controls |
| |
| 1.5 - Support and implement asset management lifecycle (i.e., hardware, software, and data) |
| |

1.6 - Support and/or implement change management lifecycle

1.7 - Support and/or implement security awareness and training (e.g., social engineering/phishing/tabletop exercises/awareness communications)

1.8 - Collaborate with physical security operations (e.g., data center/facility assessment, badging and visitor management, personal device restrictions)

2.1 - Implement and maintain authentication methods

2.2 - Understand and support internetwork trust architectures

2.3 - Support and/or implement the identity management lifecycle

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| |
| 2.4 - Understand and administer access controls |
| |
| |
| 3.1 - Understand risk management |
| |
| 3.2 - Understand legal and regulatory concerns (e.g., jurisdiction, limitations, privacy) |
| |

3.3 - Perform security assessments and vulnerability management activities

3.4 - Operate and monitor security platforms (e.g., continuous monitoring)

3.5 - Analyze monitoring results

4.1 - Understand and support incident response lifecycle (e.g., National Institute of Standards and Technology (NIST), International Organization for Standardization (ISO))

4.2 - Understand and support forensic investigations

4.3 - Understand and support business continuity plan (BCP) and disaster recovery plan (DRP)

5.1 - Understand reasons and requirements for cryptography

5.2 - Apply cryptography concepts

5.3 - Understand and implement secure protocols

5.4 - Understand public key infrastructure (PKI)

6.1 - Understand and apply fundamental concepts of networking

6.2 - Understand network attacks (e.g., distributed denial of service (DDoS), man-in-the-middle (MITM), Domain Name System (DNS) cache poisoning)

6.3 - Manage network access controls

6.4 - Manage network security

6.5 - Operate and configure network-based security appliances and services

6.6 - Secure wireless communications

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| 6.7 Secure and monitor Internet of Things (IoT) (e.g., configuration, network isolation, firmware updates, End of Life (EOL) management) |
| |
| 7.1 - Identify and analyze malicious code and activity |
| |

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| 7.2 - Implement and operate endpoint device security |
| |
| 7.3 - Administer and manage mobile devices |
| 7.4 - Understand and configure cloud security |
| |

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| 7.5 - Operate and maintain secure virtual environments |
| |
| Additional Examination Information |
| Supplementary References |
| |

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| Examination Policies and Procedures |
| |
| Agree to ISC2 policies |
| |
| ISC2 policies |
| |
| Admission Policy |
| |
| Reschedule Policy |
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| Cancellation Policy |
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Additional Information

Almost there...

Confirm Order Details

Payment Details

Exams for

Order Total

Agree to ISC2 policies

Lenovo and Intel are Driving AI Innovation at the Edge

State of Cloud 2025: Navigating EMEA's Cloud Revolution

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|---|---|
| | Python is a fast, platform-agnostic, and easy-to-learn programming language that is suited for beginners and experienced developers alike. Ever since its first release in 1991, Python has had a constant presence in the computer world and has become a go-to language thanks to its easy-to-understand code and versatility. Today, Python can boast a wide array of libraries and frameworks, and they are the cornerstone of fast and easy Python programming—the so-called Pythonic way of development. But like all programming languages, Python is not immune to security threats. Secure coding best practices must be adopted to avoid risks from attackers. In this webinar, we'll explore Python security best practices that should employed when building secure application.<br>One-Stop DevOps: Simplifying Toolchains with GitLab and Google Cloud |
| | |

Seamless Edge Deployment and Management with Lenovo and Intel

Senior Applied Scientist – Copilot Team

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| Senior Applied AI Engineer – Microsoft Security AI Research team |
| |
| Data Scientist II – Microsoft Security |
| |

Senior Applied Scientist – Power Apps

Applied Scientist II – Power Apps

Principal Applied Scientist – Advanced Autonomy and Applied Robotics

Senior Applied Scientist – Advanced Autonomy and Applied Robotics

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| Principal Researcher – Generative AI – Microsoft Research AI Frontiers |
| |
| Senior Applied Scientist |
| |

Principal Data Scientist – Real-Time Intelligence team

engineering

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<tshingombefiston@gmail.com>

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Stats

Achievements

Personal information

Confirmation

Registration details

Compare Microsoft 365 with Office

Microsoft 365 Family

Microsoft 365 Personal

Office Home 2024

Office Home & Business 2024

Frequently asked questions

Microsoft Azure AI Fundamentals

At a glance

Overview

| |
|---|
| Course Syllabus |
| |
| Search for a training provider |
| |
| Microsoft Azure AI Fundamentals |
| |
| At a glance |
| |
| Overview |
| |
| Course Syllabus |
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| Microsoft Azure AI Fundamentals |
| |
| At a glance |
| |
| Overview |
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| Course Syllabus |
| |
| Embrace responsible AI principles and practices |
| |
| Learning objectives |
| |
| Fundamentals of Generative AI |
| |
| Learning objectives |
| |
| Knowledge check |
| |
| All units complete: |
| |

Craft effective prompts for Microsoft 365 Copilot

At a glance

Prerequisites

Developer

Business or technical leader

Business user

Data scientist

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| IT professional |
| |
| Low-code developer |
| |
| ecurity professional |
| |
| Help secure your data in the age of AI |
| |
| Accelerate app development by using GitHub Copilot |
| |

C++ Standard Library reference (STL)

In this section

Use the Microsoft C++ toolset from the command line

In this article

Download and install the tools

How to use the command-line tools

Path and environment variables for command-line builds

Developer command prompt shortcuts

To open a developer command prompt window

Developer command file locations

Use the developer tools in an existing command window

vcvarsall syntax

Create your own command prompt shortcut

Command-line tools

| |
|---|
| Command-line project management tools |
| |
| In this section |
| |
| Related sections |
| |
| See also |
| |
| Azure Virtual Desktop Readiness Resources \| Microsoft Partner |
| |
| ur overall results |
| |

Categories that influenced your results

hown below are the assessment's questions and how they were answered.

Retail Readiness Resources

Marketplace Offer Development Resources

Retail Cosell Acceleration Resources

Your overall results

Categories that influenced your results

Shown below are the assessment's questions and how they were answered.

Sustainability Readiness Resources

Marketplace Offer Development Resources

Your overall results

Categories that influenced your results

Click on any field below to edit it

Recommendations for your workload.

Your overall results

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| |
| Categories that influenced your results |
| |
| Improve your results |
| |
| Recommendations for your workload. |
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| Shown below are the assessment's questions and how they were answered. |
| |
| WAF analytics service selection |
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| Analysis Services: Reliability |
| |
| Analysis Services: Security |
| |

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| Analysis Services: Cost Optimization |
| |
| Analysis Services: Operational Excellence |
| |
| Analysis Services: Performance Efficiency |
| |
| Data Factory: Reliability |
| |
| Data Factory: Security |
| |

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| Data Factory: Cost Optimization |
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| Data Factory: Operational Excellence |
| |
| Data Factory: Performance Efficiency |
| |
| Azure Databricks: Reliability |
| |
| Azure Databricks: Security |
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| Azure Databricks: Cost Optimization |
| |
| Azure Databricks: Operational Excellence |
| |
| Azure Databricks: Performance Efficiency |
| |
| Data Explorer: Reliability |
| |
| Data Explorer: Security |
| |
| Data Explorer: Cost optimization |

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| |
| Data Explorer: Operational excellence |
| |
| Data Explorer: Performance efficiency |
| |
| Synapse: Reliability |
| |
| Synapse: Security |
| |
| Synapse: Cost Optimization |
| |
| Synapse: Operational Excellence |

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| |
| Synapse: Performance Efficiency |
| |
| ADLS Gen2: Reliability |
| |
| ADLS Gen2: Security |
| |
| ADLS Gen2: Cost Optimization |
| |
| ADLS Gen2: Operational Excellence |
| |
| ADLS Gen2: Performance Efficiency |
| |

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| our overall results |
| |
| Categories that influenced your results |
| |
| Azure AI Fundamentals |
| |
| Designing and Implementing a Microsoft Azure AI Solution |
| |

| |
|---|
| Your overall results |
| |
| Categories that influenced your results |
| |
| Azure Machine Learning: Cost Optimization |
| |

Azure Machine Learning: Operational Excellence

Azure Machine Learning: Performance Efficiency

Azure Machine Learning: Reliability

Azure Machine Learning: Security

Your overall results

Categories that influenced your results

Build your plan

Past 7 days

g data issue rural system information management system education

experimental career

plus-circle Add Review

Reviews

DOWNLOAD OPTIONS

IN COLLECTIONS

tshingombe fiston | Current Job Title

Completed Courses

Courses In Progress (3)

Language Proficiency

Top Workplace Personality Strengths

Top 5 Sustainable Development Goals I Care About

Certificates

Work Experience

Educational History

Recommendations Received

Showcase Your Strongest Skills & Abilities

Skills I Possess

Additional Certificates

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1.* key calculation.

a* coverage area  calculation the coverage ,area of cellular tower can estimate using the following ,\[A=\PIr^2\]

-\(A\)=coverage area ( in square kilometres)

-\(r)=radius of coverage ( in kilometres)

Example : if a tower has a coverage radius of ,5 km

\[A=\pi(5^2)\ approx ,,78.54\ text { km } ^2\].

b. Capacity calculation: the capacity of cellular network calculated based on the number of channels available ,traffic per channel the Erlang ,B formula is commonly ,\[c=\frac{(A^B).}.{B.}\ big / sum ..

2. . Components of a cellular telephone system ,

A: cellular telephone system typicay consist of the components.

* Mobile station ( ms ) * the users device ,smart phone tower that communication with mobile stations.

* Mobile switching centre ,MSC ,
manages the communication base station
and the core networks .

* Core network,handles data routing
billing and other ,

## ,2 calculating key metrics.

a.coverage ,Area calculation the coverage
area of a base station be estimated using .

\[A=\pir^2\]

-where .\(A\)= coverage area in square kilometres .

.\(r\)= radius of coverage in kilometres ,ex : if a base station has a coverage radius of ,3 km .

\ [ A=\ pi (3^2)\ approx ,28.27\,\text ,{km} ^2\]

.b capacity calculation.

_____

To calculate the spatial  transmission characteristics of a system particularly in telecommunication.

##/ understanding spatial: transmission, spatial transmission refer to how signal private ,space transmission refer to how signal propagation space ,factor distance obstacle ,and the environment.

* Free space path loss ( fspl ) the loss of signal strength ast travel through free space.

* Multiple path propagation the phenomenon where sign effect : the change in frequency of wave in relation to an observe moving relative to source of the wave .

2 calculating free space path loss ( fspl)
the free space path loss can be calculated using .

\ [ text \ text { fspl } = 20\ log - { ,10}{d} 20 log { 10}(f)+32,44\] where : \ d = distance between the transmit and receiver , kilometres ,\(; f\)= frequency of the signal ,in megahertz ,example calculation ,if the distance ,\ d ( d ) is ,10 Kim and the frequency, ( f\) is ,900MHz ,\[\ text ,{ fspl}

---

To calculate the properties of material used and conductor insulator and magnetic material in electrical and stereo ,system ,we can analyse their characteristic.

1. Conductor : are material resistance common conductor..

- resistivity calculation the resistivity,

(\(\ rho}) of conductor is a measure of now strongly it resist the flow of electric current the resistance ,

( \(R)) Of conductor can ,

}[ R=\ rho \ frac { L}{A}\]

.\(R\)= resistance,( ohms ) .

.(\rho)= Resistivity ( ohm metre )

.(Li)= Length of the conductors meter

./ ( A\)= Cross - sectional area
,saaremeter .

Ex . Calculation for copper wire with a length of ,2 meter and a cross ,section area of \+|\ mm^2\)

( Which is / ( i\ times ,10 ^{ - 6} , m ^\))
And using the resistivity of copper ( \+\ rho \ approx ., 1,67\ times . 10^ ,=-8},| omega.| Cost m.})) ,

R= 1.68 } times , 10^

To calculate the size of  a winding for stepper motor .

1. Understanding stepper motors.

- a stepper motor is a types of DC motor that decides a full rotation into a number of equal step winding configuration and size are crucial for the motor .

* Number of phase : most stepper motor are either ,2 phase ,5 phase..

* Number of steps per revolution ,common value are ,200 steps ,( 1.8 degree per step or ,400 steps ( 0.9 degree per sleep .

* Windt configuration the arrangement winding unipolar wire gauge : the thickness of wire used for the winding effects resistance ,

3. Calculating the size of the winding :
determine the number of turns s , the
number of turns in each winding
,calculated based motor specifications :
for example ,\[ N= \ frac { v} { L csoti }\ ]

-14. measure in true.

*1 types of measure errors measure :
systematic these are considering
repeatabt errors that occurred
measurements system they.

*Random error unpredictable and can
vary from one measure.

- gross errors : the are large errors that
occure to human .

* Calibration of instruments ,calibrat is the process of adjusting instrument to ensure its measure are accurate step  for calibration.

1. Select a standard: use a reference standard.

2. Measure with the instrument take measures using the instrument.

3. Compare measurements , compare the instruments .

4. Calculate errors the errors can \[text { text error }= text { measured values \ text { true value } \]

5. Adjust the instrument if system error are found adjust .

| |
|---|
| - to perform conversion between binary hexadecimal. |
| |
| Conversion between number systeme. |
| |

* To convert a binary number to decimal ,use the formuler , \ [\ text { Decima} = sun -{ I= 0}^{n}b-1\colot 2^i/] ,where \(b_1\) is the binary digital ( 00r1) and \(n\) is the position of the difit from the rigth starting at 0 convert ,\ ( 1011_21) to decimal \ [ = 1\ colot ,2^) to decimal \[= 1\ colot ,2^3+0\ colotv,2^2+1\ CDOT,

2^1+1\ colot ,2^O= 8+0+2+1=11_{10}\]

-decimal to binary : to convert a decimal number to binary divide the number by ,2 and record the remainder , repeat until the Quotient  record  the remainder ,repeat until the Quotient is ,On

Exp : convert \ ( 1@-{10}\) to binary .

\ [ 11\div ,2=5\ qual\ text { remainder ,r=
\\ ,5 \ div ,2=2\

-to calculate the size of a memory accumulator in a binary system.

1) understanding binary representation:

In a binary system ,data is represented using bits ,binary digital where bit can either 00r,1 the number determine the range ,of value that can store .

2. Memory size calculation : the size a memory accumulator based number of bit it the total number of unique represented by an \(n\) bit binary number .

\ [ text { number of values } = 2^n\]

Where . \(n\)= numbers of bits.

| |
|---|
| * Example calculation: determine the size of the accumulation. |
| |
| 2) calculate the number of value ,\[\ text { number of values }= 2^ 8  = 256\] |
| |

This mean the accumulator can hold values from \ (01) to (255\)( decimal ,### memory size in bytes * memory size is of expressed in byte since ,1 byte = 8 bit ,size of the accumulator in bytes is \ [ text , { sizer

_____

To calculate thevenin , equivalent of a network ,short circuit current and voltage value ,

1. Thevenin theorem.

* Overview: thevenin theorem state that any linear Electrical net with voltage source and resistance can be  replaced by an equivalent circuit consisting of single voltage source ( 1(V-{the}\)) in series with with a single resistor ( \ (R-{ the}\)).

2. Step to find the in equivalent.

## a identify the portion of the circuit
select the portion the circuit for which

b calculate thevening voltage ( \( V - ( the
}\))

1.open - circuit voltage, calculate the voltage across the terminal where the load was connected this is the thevenin voltage (\(V-*{the}\))

| |
|---|
| -2 method : you voltage division nodal analysing |
| |
| - calculate thevenin resistance (\(R-{the}\)) |
| |
| - deactivated all independent source : replace independent field. |
| |

- to calculate amplification in circuits involving diodes transmission diode transistor ,and triacs understand each a analyse characteristics.

# diode amplification diode are typically not used for amplification in the Sens performance signal modulation rectification signal signal modulation rectification diode current calculation.

\[I-D= L.S \ left ( e^{\ frac { V-D}{ NV - T}} - 1 rigth .

. \(1-D\)= diode current (A).

.\(I-S\)= reverse saturation current.

. \(V-D\)= voltage across the diode ,V

.\(n\) = ideality factor ( typical between ,1
and ,2

. \ ( V-T\)= thermal voltage (\approx 26\
MV ) at room .

2. Transistor application transistor can
use common collector thermostat
common ,is common emitter amplifier .

1. Voltage gain ( \ ( A-C\))\[A-V=

_____

To analyse and calculate parameter in a control system we typically focus on aspect such systems stability response.

____ ''''''

2. Basic concepts in controle systeme.

* Open - loop control system : systeme that does not use feedback to determine if it's output has achieved the desired goal .

* Closed loop control system systeme that uses feedback to compare the actual output to the desired output.

,2 transfer function

The transfer function.

| |
|---|
| The transfer function \(H(S)\) of a control system relates the output ( V( s)\<) to the input *\ (x,(s)\) in the Laplace domain : \ [ H(s)= \ frac { y(s)}{x(s)} |
| |

3. Stability analysis , to determine the stability of a control system we can use the characteristics equation derivative the transfer function the characteristics equation is obtained by setting the denominator of the transfer function to zero

- for a transfer functions , ,\[H(S)=\ frac {k}{S^2+3S+2}\]

The characteristics equation is .

\[S^2+3s+2=0\] to find the root we can use ,

S=\ frac {-b\ pm \ start ,{ b^ 2-4ac}}{2a}

1. DC machines : speed ( n ) the speed of DC motor can be calculated using formula \[N=\ frac { V-1\ CDOT -R}{ CDOT \ Phi }\]

- where \ ( N\ ) = speed in Rpm ( revolution perminute .

- \ ( N\)= supply voltage ( v ) ,

-\(i\)= armature current (A)

\ ( R\)= armature resistance ,( ohm .

\(K\)= a constant that depends on .

.\(\ Phi\) = flux per pole ,(WB)

b ,torque ,( T) ,the torque procedure by
DC .

T= k \ CDOT } phi \ CDOT \] ,

Where .

.\(T\)= torque ,( N.m)

\(k\)= A constant that depends .

\( phi\)= flux per pole WB .

\(|\)= armature current .

_____

To calculate de gradient of a function and derive the integral of a Senegal,

1. Calculating the gradient of a function

The gradient of a function \( f(x,y)\) is a vector that contains all of its partial derivatives for a functionalite of two variables the gradient is given.

\[\ nabka , f=\ ,left(\fract { \ partial f ) {\
partial x } , \ frac \ partial f }\ partial y \
right.

f( x,y) = x^2+x^2\]

.step ,1 calculate the partial derivatives.

.\(\ frac {\ partial f}{ \ partial x }=2x \)

.\(\ frac {\ partial f }{\ partial y}= 2y , I)

. Step 2: write the gradient \[\nabla ,f =2x,2y)\]

# 2. Deriving the integral of a signal ,we typically,use the fundamental theorem of calculus ,if we have a continuous function \( f(t,,)\ the integral from \(a)to \(b\)

Is given by : \[\ into$a^ b f( f) \,dt\]

-___

To calculate derivation ,both partial total double ,triple, relate ,to signal detection.

1. Partial derivatives : partial derivatives are used dealing with functionalite of multiple variable , for a functionalite.

\(f(x,y)\) the partial derivatives with respect to \(x\)

Is denoted as \(\ frac{\ partial f }{ partial x}\) and with ,

Respect to \ ( y\) as \(\ frac {\ partial f }{\ partial ,y }\)

Examp : \[ funct \[ f( x,y)=x^2y+3xy^3\]

* Calculate partial derivatives .\(\ frac \ partial f ){ partial ,x }= 2xy+3y^2\)

.\(\ fract \ partial ,f }{ partial y }{=
x^2+6x6xy\)

* Total derivatives : the total derivatives account how a functionalite change with respect to all it variable.for a functionalite.

\( f(x,y)\), the total derivatives \ ( DF \) is given by : \[ DF = \ frac { \ partial f }{\ partial x }sx +\ frac{ \ partial }{ \ partial y } St \ ]

Using the previous : \ [ DF = 2xy+ 2y^2)

_____

- to calculate the Laplace and Fourier series Fourier a random vibrational signal ,signal aleatoire vibratoire in the context break down into a few steps.

1. Fourier series : the Fourier series and cosine function for periodic function \ ( ft)\) with period ( t) the Fourier series is.

f(t)= a 0+\ sum ${n= 1}{\ infty}

\ left + a_ n \ cos \ left \ left + } frac { 2\ pi
not }{T}

\ right ) + b _ n \ sunleft ( \ track { 2\2 Pu
,not { T}\, \ rigth \ rigth )\]

- pratical exercise related to electrical engineering

Exercises calculate the total resistance in a circuit problem statement have ,3 resistance.

Resistor ,R1= 100 ohm resistor ,R2= 20 ohm , resistor ,R3= 309 ohm

Formula for total resistance.

.\[ R-{\ text t{ total }}= R1+R2+R3\]

. Substituting the values \[ R - { \ text { total }}= 10\.\ text , { ohms }+ 20\, text{ ohms}+30\, text {ohms}\], calculating ,\[ R - { \ text { total /}} = 60\\ text { ohm }\]

---

- to calculate the supply trade theoty impedance and resonance in a electrical circuit ,we typically deal with RLC ,( resistant inductor , overview ; of impedance and resonance.

1. Impedance ,Z in a RLC circuit the total impedance is combination of resistance ,( R ) inductive reactance ,x l and capacitive reactance ,( x- c ) the formula for impedance in a series RLC ,circuit is

[ Z =\ sqrt{R^ 2+(x-L-X_C)^2}\]

Where _\(x_L= 2\ pi f L \ Pi .f.c\} ( capacitive reactance ,

| |
|---|
| -\(X_C)=\ frac ,{1}{2\ pi.f.c}\}( capacitive reactance. |
| |
| -\|(fl) is the frequency in Hertz ( z) |
| |
| -\(L/) is the inductance  in Hertz ( Hz ) , |
| | ( L /) Is the inductance in  Henry( h) |
| |
| -\( cl ) is the capacitance in farad ( f ) |
| |

2* resonance occurred in an RLC circuit when the inductive reactance equals the capacitive  reactance ( \ ( X_L= X_ C) at resonance the impedance is purely resistive and the formulation for resonance  frequency form resonance frequency ( \ ( f - I)) is \

To the calculate the  fundamental system electric power factor we need to understand relationship between real power reactive power and apparent power in electrical how to define.

1 .real power ,P owner reactive power and apparent power in electrical how to to definition real power the actual power consumed by the load measure in watt ,w

2) reactive power ,q the power the oscillator between the source and the load measured in volt amperage reactive ,varv

3 ,apparent power ,s the total power in the circuit , measure volt ampere ,Va is the combination a real and reactive power ,

- power factor calculation:

The power factor ,of is defined as the ratio of real power to apparent power , \ [ \ text power factor ,of )}=\ frac ,{P}{s}\]

Where : .\(P\)= real power ( w)

.\(S\\)= apparent power ,( VA)

## apparent power calculation

# apparent power calculay the apprent power can be calculated using the following formula .

| |
|---|
| \[S=\sqt{P^2+Q^2}\] |
| |
| .value .real power (\(P\))=500w, |
| |
| .reactive power(\Q\))=300VAR |
| |
| - calculate apparent power (<br>s)\[,S=\sqt{P^2t |
| |

- to calculate the characteristics of AC and DC machine we typically look at paramt such a peed torque and electromotive force ,( EMF) calculate these ,

Characteristics for both type machines .

-where .

|(a-O=| frac {1}{T} int- 0^ f(t)\dt)

.\+a-n = frac {2}{T} int_O^Y f ( t) \ cos\ left ( \ frac { 2\ Pi .n t}{ t } rigth \, DT have simple square wave function.

_____

- to calculate the transformation and conservation of signal in the context of electrical signal we.

1 .signal transformation Fourier transform.

- the Fourier transform is used to convert a time domain signal into it frequency domain represent formula : transform \ F ( \ omega )\( of a continuous signal \ ( f(t) , e^{- j \ omega }\ dt\]

- where . \( f+ \ omega )\) = Fourier transform of the signal.

.\( f( t )\= time - domain signal .

.\ (  \ omega \) = angular frequency in
Radia per second ..\ ( j\) = imaginary unit .

BB* Laplace transform

- the la place trans is another transformation used to analyse linear time _ invariant system formula for the la place transform \ F( S)\) of function \ ( f(t)\) is \[f(s)=\ into -{O} infty } ,  f( t ) ,, e{-st } St \]

- \( f( s)\)= Laplace transform of the signal
.

- \ f( ft c)I)= time domain signal.

_____

- to calculate and understand synchroun and synchronous system, particularly in context of linearization .

1. Synchronous systems.

- in a coordinated, governed a common clock signal , in electrical synchronise system are used in digital circuit and communication system.

- example : lineare system the state space representatation .

\|[ | dot {x}(t}=Ax(t)+By(t)\]\[y(t)=(x(t)+du(t)\]

Where :

-|(x(t)\)= state vector

.|(u(t)\)= Input vector

.\ (y( t) \)= output vector .

.(A\)= System .

.\(B\)= input matrix .

.|(C\) = Output matrix .

.\( D \ ) = feed forward.

_____

2.asynchronous system as asynchronous system operate without a global click signal operate independently and may not be synchronised this common in certain types of digital circuit and communication system .

- example equation for an asynchronous ,for an asynchronous linear systems the state space representatation .

|[| Dot { x} ( t}= Ax ( t ) + B( t) \ ]\[y(t).

_____&

To calculate the integral of an amplified signal , detection of a signal and the probability of a radon signal aleatoire.

Integral of plidie signal

If you have a signal \ f( t)\) that is amplified by a constant factor \(A\) the amplifier signal can ,be represented as \( af ( f(t)\). The integral of this amplified signal over a time interval \[a,b])\[\ int_ a^baf( t)\, St = A\ into _ a^ b ,f ( t) \ St

Exampt say \ f( t) = t ^ 2\) and \( A= 2\)
we want to calculate the integral from \ ( 0\) to \ ( 1 }):

\[\ into _0^/2t^\, St = 2\ in_ 0^ t^2\,dt\]

Calculating the integral

\[ into 0^1t 2^2\,St=\ left[ \ fract {
t^3}{3}\ rigth ]-0^1=\

Frac {1^3}{3}_\ frac { 0^ 3}{3}=\ frac {
1}{3}\}

Thus \[ \ into _ 0^ 1 ,2 T ^ 2\,dr..

_____

| |
|---|
| To calculate or design a program for artificial intelligence ,AL within an operational framework we can outline the key component and steps involved . |
| Program |
| |

- 1 define the operational framework : an operational framework for an all program typically includes the following components.

* Objective : clearly defined the purpose of the Al program classification predict optimisation

* Data source : identify the data source requirements for training and testing the Al model database ,APU real time data ,

* Algorithm : choose the appropriate Al algorithm based on the problem type ,supervised learning , unsupervised learning reinforced

1. Data collection and preprot

Data collection gather data from identified source this could involve wab departing using APIs or accessing database.

* Data cleaning : remove duplicate handle missing value and correct inconsistent in the data.

* Feature ent : select and transfy relevant feat that will be used in the modej .

3* model development.

* Select model choose the AI model based on the problem type for .

- for classification decision tree random ,forest ,support vector ,machine ,neural networks.

-* for regression linear regression
polynomial regression neural networks .

- training train  model using the  data set .

- to calculate a physical chemical plant balance we typically use the principles of mass and energy balance this,involves accounting for all input out son, accumulation of material and energy systems.structure approach to performing a mass balance physical chemical process .

2 define system : identify the boundaries of the system your are analizing this could be reactor distillation column any other unit operation in a chemical plan .

3. Identify input and output : list all the input and output system ,input can include raw material solve energy source while output / and was

-

14*. Mass balance equation : the general mass balance equation can expressed as :

\[\ text { input }-\ text { output }+\ { generation } \ text  consumption}=\ text { accumulation \ ]

- for a steady state process ( where accumulation is zero the equation simplified to \[\ text { input}\ text { output}\tezt Generation}-\ text { consumption}=\]

4.example calculation consider a simple chemical reactions input : A= 100kg / h , B =50 kg /h ,output ,,C= 120kg /h ..

.product..

_____

14.1 to calculate the derivative and integral related an electromechanical systems we typically analysis the system behaviour using differential equations that describes the dynamic of the system structure approach to derive the master equation and performance the necessary.

14.1. master  derivatives : electrical derivatives for a simple electrical circuit with an induction ,\(L\) and  a resistor \( R\/ the  voltage across the inductance can be by : \ [ V-L { L\ frac {Di}{St}\]

Where \( v-L)= voltage accross the inductor.

.\(|\){ current through the inductor .

- b mechanical derivatives:for a mechanical system the relationship between torque \ ( \tau\) and angular velocity \(\ omega \) can be described by .

\ you = |/ frac { d\ omega }{ St}\]

- where .\ ( \ tau\) = torque.

\ (\\)= moment of inertia

\( \ omega \ ) = angular velocity master

____

14.2 definition: isostatic system a system that hasjus enough support to maintain equilibrium without any redundantly it has exactly as many constraints as necessary

- hyperstatic for equilibrium leading to redundancy in constraint.

* Stability : refers to the ability of a system to return to its  original state after disturbance.

* Stability analysis: for stability analysis ,we typically use method.

Eingenvalue  analysis for a system represented by a matrix the eingenvalue can indicate stability ,if all aigenvalue have negative real part  the involved finding a lyapunov ,( function \(V(x)\) , such that \(V(X)>0\) and ,,\(\dot{(V)(X)<O\) for stability.

14.4 transformation to linear system to transform a hyperstatic system into a linear system , we can use the following step , modelling a motion ..

_____

14.6 creating a programme for a artificial intelligence ,AI , system that focuses on operational metering in electric system involves several steps , including defining the object design the architecture implementation . Algor designed the architecture implementation algoris below .

- 1 define objective

- purpose : the AI system should monitoring analyse and Optimizer electric metering operations.

14.7.

Key features:.

- real time data collection from electric meter .

- data analysis for consumption patterns.

- anomaly detection for identifying irregularity.

- predictive maintenance for meter reporting and visualisation of data.

_____

14.8. system architecture:.data source electric meter and sensor ,Day ,SQL no sQL ) to store historical data .

| |
|---|
| * Processing layer , implement data processing and analysis using AI algorithm. |
| |
| * User interface  development a dashboard for user to visualisation data and insights. |
| |

* Data collection / use API ,,direct connection to gather data from electric meters,example  shifter for data collection ,( python)

* Python,import request,def ,collect meter dentK meter data storage.

- r esponse request get ,( f" http:// API
electricity meter comparable ,/ { meter _
I'd  "} return response .jsob ( )

_____

14.9.Creating on expert system for network involved several steps . < Including defining the objective designed the architecture. Implementating the algorithm below is a structure approach to developing.

-* define objective :

Purpose .the expert system shouand ld assist in network management troubleshooting and optimisation.

* Key features: network monitoring and performance analysis troubleshooting and diagnostic capabilities.

- recommendations for network configuration.

User friendly interface for networking administratir.

2. System architecture , knowledge base a repository of network knowledge including rules ,fact and heir interference engine the core Logica knowledge base derive,user interface

- implementation step : knowledge base
developm.protocols configuration
common issues and solutions

-plain text .

If network _speed < threshold

Then

If packet _ loss >

Acceptable _ level then

Recommended _ check _ hardware.

- inference Engine implement the inference Engine to process user queries and apply the rules from  from the knowledge base.

Ex code snippet , python.

Python

Class expert system

Def _ initi_ self

Self . knowledge base

- to  analyse a pneumatic hydraulic vibratory system equation governing the system and performance integrals

1. Understanding the system ,A pneumatic - hydraulic

Vibrator system typically consist of

* Pneumatic components : air driven actuator or cylinder.

* Hydraulic components : fluid driven actuator or cycle

16.hydraulic components:fluid driver actuator or cylinder .

* Vibratory mechanism , A system that produces oscillator or vibration, oft used in applications like material.

2 . deriving equation for a pneumatic hydraulic system the dynamic described using Newton second low and the principles of fluid mechanics

_1 force balance the net force acting on the system,express as \F-{\text { net }}=F-{\ text { pneumatic}}++ ,

F-{\text { hydraulic }}- , F {\ text { damping }}-F{\ text ( inertial }}

2.* Pneumatic force .the force generated by a pneumatic actuator.

_____

To derive the relationship force ,motion.
,power ,energy .

\[F= m\ CDOT a \ ] where.

.\(F\) = force ( N) , | \ ( m \)= mass ( kg )
|\(a)= acceleration ,( m/s.s)

* Work done by a force : work ( \(w\) is defined as the force applied to an object time distance (\(d\) over which the force

Is applied in the direction force .

|[ W= F \ CDOT d \ CDOT \ cos( \thita \]

.\(w\)= work ,joule

.\( f\)= force ,N

.(d\)= Distance,m

.\(\ theta \ ) = angle between .

,3 energy :

Kinetic energy ,( k.E) is the energy of an object du it's motion .

\[K.E= \frac {I}{2}.m.V^2\..

Where .

\(V\)= velocity ( m/s)..to analizing the concept of magnetic electromagnet and electrodynamics,system in relation silence ,or damping and solenoids

_____

- understanding the concept.

- solenoid ,a coil of wire generate a magnetic field an electrical current pass through it.

* Magnetic moment ,A measure of the strength and director of a magnetic source

* Electromagnetic induction , a measure of the strength and direction of a magnetic source .

* Electromagnetic.iduction .the process
by changing magnetic.field induce and
electromotive force ,EMF ,in a conductor .

* Electocinectic ; refer to the motion of charged | particle a fluid under the inference of an electric field  magnetic moment of solenoid..- the magnetic of solenoid.

-the magnetic moment (\(m\)) of a solenoid, \[ m=n\cdot \cdot A \]

Where . \+Cn\)= number of turns per unit length ,turns / m

\(\)= current throughout the solenoid ,A

\(A\) = cross - sectional area of the solenoid,mm. Electromagnetic induction

- according to Faraday los electromagnetic the induce

_____

16.3.The term Quotient intellectual calculus is term in mathematics or intellectual ass.

- intellectual Quotient ,( iQ) ,the ,IQ is a measure of a personal intellectual abilities in relation to standardise test that assess various  cognitive skill .

- IQ \[ \ text {IA}=\ left (\ frac { text {
mental age }}{\ text { chronological age }}\
rigth ) \ time ,100\]

- mental age : the age level at which a
person perform intellectual.

- chronological age : the actual >

2.Quotient in calculus.

If you have two function \ ( f(x) and \(g(x)\).the quotient \ [ A(X)=\ frac {f(x){g(x)}

3.calxukating the derivative of a quotient , [ fract = d}{dx{\ left ( \ fract { f ( x) }{g(x)\ rigth )

_____

- to analyse psychometric variance ,variance in electrical psychometric field of study concerned with theory of psychopedagogie measurements knowledge ability attides and personality traits in this psychometric test analysed staatiscally ..

2. Calculating variance  is statistics measure that represent the degree of spread in set of value in the of electrical measurements.for variance : the variance (\{} sigma ^2\)) of a set of values \(x_1,x_2\ isots ,x_n\) is calculated using formula

€[| sigma ^2= \ frac { 1}{n}\ sum _ {I=1}^{x_i_\ mu )^2\]

- \(\ sigma ^ 2\)= variance

.(X_1\) = Each inductive . observations

- formulation

_____

In electrical engineering under is crucial
for analyse data  especially.

1) variance : measure how a set of value
differ from the mean of set it quantite
the spread of the data paint .

-for a set of \(n\) observt it quantt the spread of the data .

Point formula for variance.

For a set of \(n\) observations \(x_1,x_2,\ isots ,x_ n \)

|[| Sigma ^2=\ frac {1}{n} sum_

{I=1}^{n}(x_1-\mu)^2

Where.\(\ sigma ^ 2))= variance.

.\(n\)= number of observations .

.\(xi)= each individual observation .

.\(| mu\)= mean of thicd ..

---\[|my= \ frac {1}{n} sum _ { I= 1}{n}, x
_1\]

_____

2.covariance measure the degree to which two the degree  to which two random variables change together indicate the direction of the linear relationship between the variable : { foetus set of observations \ (x=(x_1,x-2\dot ,x_ n )\) and \ + y= ( y-@,y-2,\ idots ,y-n

3. Calcul the electrical installation requirements for a building term .

- understanding power and energy .

* Power ,O * measure in kilowatt ( kW ) it represent the rate at which electrical energy is consumt products .

* Energy ,( E) : measured in kilowatt  hour ,kWh it represents.

.\[ E= O\ times \ ]

.\(E\)= energy in kWh

.\( P\)= power in kW

.\( t\) = time in hours .

- 2 calculating total power demand to
calculate the total power for a building.

- list of electrical load ligthning ,10
fixtures a ,15 watt each ,HVAC : 3 kW ,
appliances ,2 kW other equipment ,1 kW ..

2 calculate total power demand ligthning
\(10\ text{ fixtures \ times

calculations involved in those areas.
Here's a breakdown:

1. Signal Processing

- Fourier Transforms and Spectral Analysis

- Calculate the Fourier transform X(f)X(f) of a time-domain signal x(t)x(t): $$X(f) = \int_{-\infty}^{\infty} x(t)e^{-j2\pi ft} dt$$

- Use spectral analysis to identify frequency components and bandwidth.

- Filter Design

- Design digital filters using the Z-transform and filter specifications (e.g., cutoff frequency, filter order): $$H(z) = \frac{b_0 + b_1z^{-1} + \cdots + b_Mz^{-M}}{1 + a_1z^{-1} + \cdots + a_Nz^{-N}}$$

- Analyze filter response and stability.

2. Communication Systems

- Modulation and Demodulation

- Calculate modulation index mm for amplitude modulation (AM): $$m = \frac{A_m}{A_c}$$ where AmA_m is the amplitude of the message signal and AcA_c is the amplitude of the carrier signal.

| |
|---|
| ○ Determine the bandwidth of frequency-modulated (FM) signals using Carson's rule: $$BW = 2(\Delta f + f_m)$$ where Δf\Delta f is the frequency deviation and fmf_m is the maximum modulating frequency. |

•□Signal-to-Noise Ratio (SNR)

| |
|---|
| ○ Calculate the SNR for a communication system: $$\text{SNR} = 10 \log_{10}\left(\frac{P_{signal}}{P_{noise}}\right)$$ where PsignalP_{signal} is the power of the signal and PnoiseP_{noise} is the power of the noise. |
| |
| 3. Information Theory |
| |

- Entropy and Information Content

- Calculate the entropy H(X)H(X) of a discrete random variable XX: $$H(X) = -\sum_{i} P(x_i) \log_2 P(x_i)$$ where P(xi)P(x_i) is the probability of the ii-th outcome.

- Channel Capacity

- Determine the channel capacity CC using the Shannon-Hartley theorem: $$C = B \log_2 \left(1 + \frac{S}{N}\right)$$ where BB is the bandwidth of the channel, SS is the signal power, and NN is the noise power.

4. Network Theory

- Network Topologies and Protocols

- Analyze network performance metrics such as latency, throughput, and packet loss for different topologies (e.g., star, mesh).

- Use queuing theory to model and evaluate network performance.

5. Electromagnetic Theory

- Maxwell's Equations

| |
|---|
| ○ Apply Maxwell's equations to solve for electric and magnetic fields in communication systems: $$\nabla \cdot \mathbf{E} = \frac{\rho}{\epsilon_0}$$ $$\nabla \cdot \mathbf{B} = 0$$ $$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$ $$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \epsilon_0 \frac{\partial \mathbf{E}}{\partial t}$$ |
| |
| 6. Digital Communication |
| |

- Error Detection and Correction

- Calculate the Hamming distance and error-detecting/correcting capabilities of codes.

- Use cyclic redundancy check (CRC) to detect errors in transmitted dat

1. Signal Processing

•□Fourier Transforms and Spectral Analysis:

| | |
|---|---|
| | ○ Used to convert time-domain signals to frequency-domain representations for analyzing and filtering signals. For example, Fourier transforms are used in OFDM (Orthogonal Frequency Division Multiplexing) systems in 4G and 5G networks to enable efficient data transmission. |
| | |
| | •□Filter Design: |

- Digital filters are designed using Z-transforms to remove noise and interference from signals. This is crucial in audio and video streaming services to ensure clear and high-quality transmission.

2. Communication Systems

•□Modulation and Demodulation:

- Modulation techniques like QAM (Quadrature Amplitude Modulation) and PSK (Phase Shift Keying) are used in transmitting data over various communication channels. Calculations for modulation index and bandwidth are critical in maximizing data rates while minimizing interference.

•□Signal-to-Noise Ratio (SNR):

- SNR calculations are used to assess the quality of received signals. High SNR is essential for maintaining clear communication in wireless networks, satellite communications, and broadcasting.

3. Information Theory

•□Entropy and Information Content:

- Calculations of entropy help in designing efficient coding schemes, such as Huffman coding and Shannon-Fano coding, which are used in data compression algorithms to reduce the amount of data transmitted.

- Channel Capacity:

- Determining the channel capacity helps in optimizing the usage of available bandwidth. This is vital in designing systems like DSL (Digital Subscriber Line) and fiber-optic communication to achieve high data rates.

4. Network Theory

•□Network Topologies and Protocols:

- Performance metrics such as latency, throughput, and packet loss are calculated to design and optimize network topologies. For example, in Wi-Fi networks, these metrics ensure efficient data transmission and minimal delays.

5. Electromagnetic Theory

•□Maxwell's Equations:

- Applied to design and analyze antennas and propagation models in wireless communication. Engineers use these calculations to ensure optimal signal strength and coverage in cellular networks, GPS, and satellite communications.

6. Digital Communication

•□Error Detection and Correction:

| | |
|---|---|
| | ○ Error-detecting and correcting codes like Hamming codes and Reed-Solomon codes are calculated and implemented to ensure data integrity during transmission. These are widely used in storage devices, CDs/DVDs, and data transmission systems. |
| | |
| | Practical Examples: |
| | |
| | Mobile Networks (4G/5G) |
| | |

•□**OFDM:** Fourier transforms are used to split data into multiple frequency bands, allowing simultaneous data transmission and improving spectral efficiency.

| | |
|---|---|
| •□**MIMO (Multiple Input Multiple Output):** SNR and channel capacity calculations optimize the use of multiple antennas, enhancing data rates and signal quality. | |
| | |
| | Satellite Communication |
| | |

•□**Link Budget Analysis:**
Calculations for SNR, modulation schemes, and error correction ensure reliable communication links between satellites and ground stations.

| | |
|---|---|
| | •□**Doppler Shift Compensation:** Calculations are used to adjust for frequency shifts due to the relative motion of satellites and receivers. |
| | |
| Optical Fiber Communication | |
| | |

•□**Wavelength-Division Multiplexing (WDM):** Spectral analysis ensures multiple data streams are transmitted simultaneously over different wavelengths, maximizing bandwidth.

| |
|---|
| •□Dispersion Management: Calculations for dispersion compensate for signal spreading in the fiber, maintaining signal integrity over long distances. |
| |
| IoT (Internet of Things) |
| |

•□**Power Efficiency Calculations:** Ensuring low power consumption in IoT devices through efficient modulation schemes and data transmission protocols.

- **Network Scaling:** Calculations for network capacity and data flow ensure seamless connectivity and communication between a large number of IoT devices.

These calculations are vital for the successful implementation and optimization of modern communication systems, enabling high-speed, reliable, and efficient communication across various platforms and technologies. If you have a specific communication system or technology in mind, I can provide more detailed examples of how calculations are applied.

## Solar Power Systems

Calculations for designing and optimizing solar power installations:

1. Solar Panel Output Calculation

•□**Formula:** $$ P = A \times G \times \eta $$ Where:

- PP is the power output (Watts)

- AA is the area of the solar panel (square meters)

- GG is the solar irradiance (Watts per square meter)

- η\eta is the efficiency of the solar panel

2. Optimal Tilt Angle Calculation

- Formula:

- For fixed solar panels:
$$ \theta_{opt} = \text{Latitude} \pm 15^\circ $$

| |
|---|
| ○ Adjust based on seasonal changes: |
| |

| |
|---|
| ▪·Winter:<br>θopt=Latitude+15<br><br>∘\theta_{opt} =<br><br>\text{Latitude} +<br>15^\circ |
| |

▪·Summer:
θopt=Latitude−15

∘\theta_{opt} =

\text{Latitude} -
15^\circ

3. Orientation Calculation

•□Formula:

- The optimal orientation for solar panels in the Northern Hemisphere is true south, while in the Southern Hemisphere, it is true north.

- **Azimuth Angle:** $$
\gamma = 180^\circ
\text{ (South) or 0^\circ
\text{ (North)} $$

- Adjustments might be necessary depending on local shading and obstacles.

4. Panel Configuration Calculation

•□Series and Parallel Connections:

- **Series:** Voltage adds up, current remains the same. $$ V_{total} = \sum_{i=1}^{n} V_i $$

- **Parallel:** Current adds up, voltage remains the same. $$ I_{total} = \sum_{i=1}^{n} I_i $$

## Wind Energy Projects

Calculations for optimizing wind turbine installations:

1. Power Output Calculation

•□**Formula:** $$ P = \frac{1}{2} \rho
A v^3 \eta $$ Where:

- PP is the power output (Watts)

- ρ\rho is the air density (kg/m³)

- AA is the swept area of the turbine blades ($m^2$)

- vv is the wind speed (m/s)

- η\eta is the efficiency of the turbine

2. Optimal Location Calculation

- Formula:

- **Capacity Factor:**
  Average power generated divided by the rated peak power. $$ \text{Capacity Factor} = \frac{\text{Average Power Output}}{\text{Rated Peak Power}} $$

- Areas with higher average wind speeds are preferred. Use wind resource maps and data.

3. Turbine Size and Design Calculation

- Formula:

- **Rotor Diameter:** $$ D = 2 \sqrt{\frac{A}{\pi}} $$

- Where DD is the rotor diameter and AA is the swept area.

4. Environmental Impact Calculation

- Formula:

- **Noise Level:** Calculate expected noise levels at various distances. $$ L = L_0 - 20 \log_{10}(d) $$

- Where LL is the noise level at distance dd from the source, and L0L_0 is the noise level at the reference distance.

These calculations are integral to ensuring that renewable energy systems are both efficient and environmentally friendly. If

1. Fourier Transforms and Spectral Analysis

Fourier transforms are crucial for converting time-domain signals to frequency-domain representations. This is essential for analyzing and filtering signals, particularly in applications like OFDM (Orthogonal Frequency Division Multiplexing) used in 4G and 5G networks.

Fourier Transform:

•□**Definition:** $$ X(f) = \int_{-\infty}^{\infty} x(t) e^{-j2\pi ft} dt $$ Where:

- X(f)X(f) is the frequency-domain representation of the signal.

- x(t)x(t) is the time-domain signal.

- jj is the imaginary unit.

- ff is the frequency.

•□**Inverse Fourier Transform:** $$
x(t) = \int_{-\infty}^{\infty} X(f)
e^{j2\pi ft} df $$

Example - OFDM:

- In OFDM, multiple carriers are modulated with the data stream, and Fourier transforms are used to multiplex and demultiplex the carriers efficiently.

•□**Calculations:** Transform the data from the time domain to the frequency domain before transmission and back to the time domain upon reception, using the FFT (Fast Fourier Transform) algorithm.

2. Filter Design

Digital filters are designed using Z-transforms to remove noise and interference from signals, ensuring clear and high-quality transmission in audio and video streaming services.

Z-Transform:

•□**Definition:** $$ H(z) = \frac{Y(z)}{X(z)} $$ Where:

- H(z)H(z) is the transfer function of the digital filter.

- Y(z)Y(z) is the Z-transform of the output signal.

- X(z)X(z) is the Z-transform of the input signal.

Example - FIR Filter:

•□**FIR (Finite Impulse Response) Filter Design:** $$ H(z) = \sum_{k=0}^{N-1} h[k] z^{-k} $$ Where h[k]h[k] are the filter coefficients.

•□Design Steps:

1. Specify the desired frequency response.

2. Determine the filter order NN.

3. Calculate the filter coefficients h[k]h[k].

Communication Systems Calculations

Modulation and Demodulation

Modulation techniques like QAM (Quadrature Amplitude Modulation) and PSK (Phase Shift Keying) are used to transmit data over communication channels efficiently.

Quadrature Amplitude Modulation (QAM):

•□**Formula:** $$ s(t) = I(t) \cos(2 \pi f_c t) - Q(t) \sin(2 \pi f_c t) $$
Where:

- I(t)I(t) and Q(t)Q(t) are the in-phase and quadrature components of the signal.

- fcf_c is the carrier frequency.

Phase Shift Keying (PSK):

•□**Formula:** $$ s(t) = \cos(2 \pi f_c t + \theta) $$ Where:

- θ\theta is the phase shift representing the data.

Example - QAM Modulation:

- Steps:

1. Map the input data to QAM symbols.

2. Generate the modulated signal using the QAM formula.

Example - PSK Modulation:

- Steps:

1. Map the input data to phase shifts.

2. Generate the modulated signal using the PSK form

1. MIMO (Multiple Input Multiple Output) Systems

**SNR (Signal-to-Noise Ratio) Calculation:**

•□**Definition:** SNR is the ratio of the power of the signal to the power of the background noise.

•□**Formula:** $$ \text{SNR} = \frac{P_{signal}}{P_{noise}} $$

| |
|---|
| ○ In decibels (dB): $$ \text{SNR}*{dB} = 10 \log {10}\left(\frac{P_{signal}}{P_{noise}}\right) $$ |
| |
| Channel Capacity Calculation: |
| |

•□**Shannon-Hartley Theorem:** $$ C = M \cdot B \cdot \log_2 (1 + \text{SNR}) $$ Where:

- CC is the channel capacity (bps)

- MM is the number of antennas

- BB is the bandwidth (Hz)

- SNR\text{SNR} is the Signal-to-Noise Ratio

## 2. Satellite Communication

**Link Budget Analysis:**

•□**Definition:** A link budget accounts for all gains and losses from the transmitter, through the medium, to the receiver in a telecommunication system.

•□**Formula:** $$ P_{r} = P_{t} + G_{t} + G_{r} - L_{p} - L_{s} - L_{m} $$ Where:

- PrP_{r} is the received power (dBm)

- PtP_{t} is the transmitted power (dBm)

- GtG_{t} is the transmitter antenna gain (dBi)

- GrG_{r} is the receiver antenna gain (dBi)

- LpL_{p} is the free-space path loss (dB)

- LsL_{s} is the system losses (dB)

| |
|---|
| ○ LmL_{m} is the miscellaneous losses (dB) |
| |
| Doppler Shift Compensation: |
| |

•□**Definition:** Doppler shift is the change in frequency of a wave in relation to an observer moving relative to the source of the wave.

•□**Formula:** $$ f_d = \frac{v}{c} f_s
$$ Where:

- fdf_d is the Doppler shift

- vv is the relative velocity between the source and observer

- cc is the speed of light

- fsf_s is the source frequency

## 3. Optical Fiber Communication

**Wavelength-Division Multiplexing (WDM):**

- Spectral Analysis:

  - **Fourier Transform:** $$
X(f) = \int_{-
\infty}^{\infty} x(t) e^{-
j2\pi ft} dt $$

Dispersion Management:

- **Definition:** Dispersion in optical fibers causes pulse spreading, reducing signal quality over long distances.

•□**Formula:** $$ D = \frac{d\tau}{d\lambda} = \frac{d^{2\beta}}{d\lambda^2} $$ Where:

- DD is the dispersion parameter

- τ\tau is the pulse broadening

- λ\lambda is the wavelength

- β\beta is the propagation constant

## 4. IoT (Internet of Things)

**Power Efficiency Calculations:**

•□**Definition:** Ensuring low power consumption in IoT devices.

•□Formula:

- **Energy Consumption:**

$$ E = P \times t $$

Where:

- EE is the energy consumption

- PP is the power consumption

- tt is the time

**Network Scaling:**

| |
|---|
| •□**Definition:** Ensuring the network can scale efficiently with the addition of new devices. |
| |
| •□Formula: |

- **Network Capacity:** $$ C = B \cdot \log_2 (1 + \text{SNR}) $$ Where:

- CC is the capacity

- BB is the bandwidth

- SNR\text{SNR} is the Signal-to-Noise Ratio

Communication technology has evolved significantly over centuries, transforming how we share information and connect with each other. Here are some key historical milestones:

Ancient Times

•□**100,000 BC:** Development of human speech, enabling verbal communication

Integral Derivation in Thermodynamics:

•□**Gibbs Free Energy (**ΔG\Delta G**)**
**Calculation:**

- Formula for the Gibbs free energy change: $$ \Delta G = \Delta H - T \Delta S $$ Where:

▪·ΔH\Delta H is the enthalpy change

▪·TT is the temperature (in Kelvin)

▪·ΔS\Delta S is the entropy change

•□Nernst Equation:

- Used to calculate the cell potential under non-standard conditions: $$ E = E^\circ - \frac{RT}{nF} \ln Q $$ Where:

| | |
|---|---|
| ▪·EE is the cell potential | |
| | |

▪·E∘E^\circ is the

standard cell
potential

▪·RR is the universal gas constant

▪·TT is the temperature (in Kelvin)

▪·nn is the number of moles of electrons

▪·FF is Faraday's constant

▪·QQ is the
reaction quotient

Kinetics and Electron Transfer Processes:

- Rate of Reaction:
    - Formula for the rate of an electrochemical reaction: $$ \text{Rate} = k[A]^{m[B]}n $$ Where:

▪·kk is the rate constant

▪·[A][A] and [B][B] are the concentrations of reactants

▪·mm and nn are the reaction orders

•□Butler-Volmer Equation:

- Describes the current density as a function of overpotential: $$ j = j_0 \left( \exp \left( \frac{\alpha n F \eta}{RT} \right) - \exp \left( -\frac{(1-\alpha) n F \eta}{RT} \right) \right) $$
Where:

▪·jj is the current density

▪·j0j_0 is the exchange current density

▪·α\alpha is the charge transfer coefficient

▪·η\eta is the overpotential

System Design and Operation

•□Electrochemical Cell Design:

- **Anode and Cathode Selection:** Choosing appropriate materials for the anode and cathode based on their electrochemical properties.

- **Electrolyte:** Selecting the right electrolyte to ensure efficient ion transport and minimal resistance.

- **Configuration:**
  Designing the cell layout to optimize performance, durability, and safety.

•□Operational Parameters:

- **Temperature Control:** Ensuring the system operates within the optimal temperature range for maximum efficiency.

- **Current Density:**
  Regulating the current density to balance between reaction rate and energy efficiency.

- Maintenance:
  Implementing regular maintenance protocols to ensure the longevity and reliability of the system.

## Battery Technologies for Infrastructure

**Lithium-ion Batteries:**

- Structure:
  - Composed of a positive electrode (cathode), a negative electrode (anode), and an electrolyte that allows for ion transport.

- Function:
    - During discharge, lithium ions move from the anode to the cathode through the electrolyte, releasing energy.

- Applications:

  - Widely used in portable electronics, electric vehicles, and grid energy storage due to their high energy density and long cycle life.

**Lead-acid Batteries:**

•□Traditional Uses:

- Commonly used in automotive applications for starting, lighting, and ignition (SLI) due to their reliability and cost-effectiveness.

•□Modern Improvements:

| |
|---|
| ○ Enhanced designs for better performance, such as AGM (Absorbent Glass Mat) and gel batteries, which offer improved safety and efficiency. |
| |
| Emerging Technologies: |
| |

•□Solid-state Batteries:

- Use a solid electrolyte instead of a liquid one, offering higher energy density, improved safety, and longer life cycles.

•□Other Advanced Technologies:

- Exploring batteries like lithium-sulfur, lithium-air, and flow batteries for specific applications requiring high energy capacity and efficien

34.6 Performance Benefits of Immutable Data

Investigating the performance benefits that immutable data can bring to web applications and how these benefits can be maximized.

Performance Improvements

Understanding how immutable data can enhance performance:

**1.** Reduced Unnecessary Re-renders:

- **Explanation:** In web applications, especially those using frameworks like React, immutable data structures can help optimize re-rendering processes. By ensuring data is unchanged, the application can more efficiently determine when to re-render components.

- **Calculation:** Suppose O(n)O(n) is the complexity for checking if data has changed.

▪·**Mutable Data:** Every change requires a deep comparison, leading to higher computational costs.

▪·**Immutable Data:** Directly comparing references, leading to O(1)O(1) complexity for detecting changes, reducing overhead.

**2.** Improved Debugging and Testing:

- **Explanation:**
  Immutable data structures can make debugging and testing easier because the data state is predictable and stable, leading to fewer side effects.

- **Calculation:** Less time spent on debugging and fewer bugs introduced due to unexpected data mutations.

Optimization Techniques

Techniques for maximizing the performance benefits of immutable data:

**1.** Use of Libraries:

- **Immutable.js:** A library providing persistent immutable data structures.

▪·Example:

```
javascript
```

## 38.7 Electrochemical Sensors and Monitoring

Integral and Derivative Calculations in Electrochemical Sensors

| |
|---|
| Design and Function: |
| |
| Electrochemical sensors are designed to detect and measure specific chemical compounds by generating an electrical signal that is proportional to the concentration of the compound of interest. These sensors are commonly used for monitoring environmental conditions and assessing the structural health of infrastructure. |
| |
| Integral Calculations: |
| |

•□Signal Integration:

- To measure the total amount of analyte over time, integration of the sensor signal I(t)I(t) is performed: $$ Q = \int_0^T I(t) \, dt $$

- Where QQ is the total charge, I(t)I(t) is the current as a function of time, and TT is the total time period.

Derivative Calculations:

•□Rate of Change:

- To assess the rate of change of the analyte concentration, the derivative of the sensor signal can be calculated: $$ \frac{dC}{dt} = k \frac{dI}{dt} $$

- Where CC is the concentration, II is the current, and kk is a constant.

38.8 Electrolysis and Industrial Processes

Integral and Derivative Calculations in Electrolysis

Water Splitting for Hydrogen Production:

•□Integral Calculations:

- Total Hydrogen Production: $$ H_2 (g) = \int_0^T \left( \frac{I(t)}{2F} \right) dt $$

▪·Where H2H_2 is the amount of hydrogen gas produced, I(t)I(t) is the current as a function of time, FF is Faraday's constant, and TT is the total time.

- Derivative Calculations:

- **Current Density:** $$ J = \frac{dI}{dA} $$

▪·Where JJ is the current density, II is the current, and AA is the electrode area.

Metal Plating:

•□Integral Calculations:

- **Total Metal Deposited:**

$$ M = \int_0^T \left(
\frac{I(t) \cdot M}{nF}
\right) dt $$

▪·Where MM is the mass of the metal deposited, I(t)I(t) is the current as a function of time, nn is the number of electrons involved in the reaction, FF is Faraday's constant, and TT is the total time.

- Derivative Calculations:

- **Rate of Deposition:** $$
\frac{dM}{dt} = \frac{I(t)
\cdot M}{nF} $$

▪·Where dM/dtdM/dt is the rate of metal deposition.

## 38.9 Sustainability and Electrochemical Engineering

### Impact on Sustainable Infrastructure Development

| Energy Efficiency: |
| --- |
| |
| •□Integral Calculations: |

- Energy Consumption:

$$ E = \int_0^T P(t) \, dt
$$

▪·Where EE is the total energy consumption, P(t)P(t) is the power consumption as a function of time, and TT is the total time period.

Resource Recovery:

•□Integral Calculations:

- Recovered Resources:
$$ R = \int_0^T r(t) \, dt
$$

▪·Where RR is the total amount of resources recovered, r(t)r(t) is the recovery rate as a function of time, and TT is the total time period.

Environmental Impact:

- Derivative Calculations:

- Rate of Emission Reduction: $$
\frac{dE_r}{dt} = f(t) $$

▪·Where ErE_r is the emission reduction, and f(t)f(t) is a function representing the rate of emission reduction over tim

5. Automating Electrical Design Processes

**Key Topics:**

•□**Repetitive Task Automation:** Identifying and automating repetitive tasks in electrical design.

•□**Efficiency Improvement:**
Enhancing efficiency and productivity through automation.

•□**Error Reduction:** Minimizing human errors.

Integral and Derivative Calculations in Automating Electrical Design Processes

**Repetitive Task Automation**

Identifying and Automating Repetitive Tasks:

- Integral Calculations:

- **Total Time Spent on Repetitive Tasks:** $$ T = \int_0^N t_i \, di $$

▪·Where TT is the total time, tit_i is the time spent on each task, and NN is the total number of tasks.

- Derivative Calculations:

- **Rate of Task Completion:** $$ \frac{dT}{dt} = \text{Rate of Task Completion} $$

▪·Where TT is the number of tasks and tt is the time.

Example:

| |
|---|
| •□Identifying tasks such as circuit simulations, schematic updates, and documentation that can be automated using Robotic Process Automation (RPA) tools like UiPath or Automation Anywhere. |
| |
| Efficiency Improvement |
| |
| Enhancing Efficiency and Productivity through Automation: |
| |

•□Integral Calculations:

- **Total Efficiency Gain:**

$$ E = \int_0^T \frac{P_a - P_m}{P_m} \, dt $$

▪·Where EE is the efficiency gain, PaP_a is the productivity with automation, PmP_m is the productivity without automation, and TT is the total time.

- Derivative Calculations:

- **Rate of Efficiency Improvement:** $$ \frac{dE}{dt} = \text{Rate of Efficiency Improvement} $$

▪·Where EE is the efficiency and tt is the time.

Example:

| | |
|---|---|
| | •□Automating tasks such as generating Bill of Materials (BOM), performing simulations, and generating design reports to save time and reduce manual effort. |
| | |
| | Error Reduction |
| | |
| | Minimizing Human Errors: |
| | |

•□Integral Calculations:

- **Total Errors Before and After Automation:** $$ E_{\text{total}} = \int_0^N e_{\text{manual}} \, di - \int_0^N e_{\text{automated}} \, di $$

▪·Where $E_{\text{total}}$ is the total error reduction, $e_{\text{manual}}$ is the error rate with manual processes, $e_{\text{automated}}$ is the error rate with automated processes, and $N$ is the total number of tasks.

- Derivative Calculations:

- **Rate of Error Reduction:** $$ \frac{dE_r}{dt} = \text{Rate of Error Reduction} $$

▪·Where ErE_r is the error reduction and tt is the time.

Principles and practices of effective project management tailored to electrical engineering projects and infrastructure.

Key Topics:

•□Project Planning:

- Techniques for planning electrical engineering projects.

•□Resource Management:

- Managing resources effectively in electrical projects.

- Risk Management:

- Identifying and mitigating risks.

Integral and Derivative Calculations in Project Management

**Project Planning**

Techniques for planning electrical engineering projects:

•□Integral Calculations:

- **Total Project Time:** $$
T = \int_0^N t_i \, di $$

▪·Where TT is the total project time, tit_i is the time for each task, and NN is the total number of tasks.

- **Cumulative Budget:** $$
B = \int_0^T b(t) \, dt $$

▪·Where BB is the total budget, and b(t)b(t) is the budget allocation over time TT.

- Derivative Calculations:

- **Rate of Task Completion:** $$ \frac{dN}{dt} = \text{Rate of Task Completion} $$

▪·Where NN is the number of completed tasks, and tt is the time.

Example:

•Creating Gantt charts and project timelines by integrating task durations to visualize the overall project schedule.

Resource Management

Managing resources effectively in electrical projects:

•□Integral Calculations:

- Total Resource Allocation: $$ R = \int_0^T r(t) \, dt $$

▪·Where RR is the total resource allocation, and r(t)r(t) is the resource allocation rate over time TT.

- Derivative Calculations:

- **Rate of Resource Utilization:** $$ \frac{dR}{dt} = \text{Rate of Resource Utilization} $$

▪·Where RR is the resource utilization, and tt is the time.

Example:

| |
|---|
| •Estimating the total amount of resources (e.g., labor, equipment) needed for the project by integrating resource usage over time. |
| |
| Risk Management |
| |
| Identifying and mitigating risks: |
| |

•□Integral Calculations:

- **Cumulative Risk**

**Impact:** $$ I = \int_0^T i(t) \, dt $$

▪·Where II is the total risk impact, and i(t)i(t) is the impact of risks over time TT.

- Derivative Calculations:

- **Rate of Risk Occurrence:** $$ \frac{dR}{dt} = \text{Rate of Risk Occurrence} $$

▪·Where RR is the risk occurrence, and tt is the time

Wind Energy, Solar Energy, and Hydroelectric Power

Wind Energy: Understanding the Technology and Integration

- Integral Calculations:

- **Total Power Output:** $$
P_{\text{total}} = \int_0^T
P(t) \, dt $$

▪·Where PtotalP_{\text{total}} is the total power output over time TT, and P(t)P(t) is the power at time tt.

- **Energy Harvested:** $$ E = \int_0^T \frac{1}{2} \rho A v^3 \eta \, dt $$

▪·Where EE is the energy harvested, ρ\rho is the air density, AA is the swept area of the turbine blades, vv is the wind speed, and η\eta is the efficiency.

- Derivative Calculations:

- Rate of Change of Power Output: $$ \frac{dP}{dt} $$

▪·Where PP is the power output and tt is the time.

Solar Energy: Exploring Photovoltaic Systems

•□Integral Calculations:

- Total Energy

Generated: $$

E_{\text{total}} = \int_0^T

P(t) \, dt $$

▪·Where EtotalE_{\text{total}} is the total energy generated, and P(t)P(t) is the power output at time tt.

- **Energy Efficiency:** $$
\eta =
\frac{E_{\text{generated}}}
{E_{\text{incident}}} $$

▪·Where η\eta is the efficiency, EgeneratedE_{\text{generated}} is the energy generated by the solar panel, and EincidentE_{\text{incident}} is the incident solar energy.

- Derivative Calculations:

- Rate of Energy Generation: $$ \frac{dE}{dt} = P(t) $$

▪·Where EE is the energy and tt is the time.

Hydroelectric Power: Implementing Hydroelectric Systems

•□Integral Calculations:

- **Total Energy Production:** $$ E = \int_0^T P(t) \, dt $$

▪·Where EE is the total energy production, and P(t)P(t) is the power output at time tt.

- Hydraulic Head Calculation: $$ H = \int_{z_1}^{z_2} dz $$

▪·Where HH is the hydraulic head, and z1z_1 and z2z_2 are the initial and final elevation levels.

- Derivative Calculations:

- **Rate of Flow:** $$
\frac{dQ}{dt} $$

▪·Where QQ is the flow rate and tt is the time.

Electrical Infrastructure Design and Management

Infrastructure Planning

•□Integral Calculations:

- **Total Project Time:** $$
T_{\text{total}} = \int_0^N
t_i \, di $$

▪·Where TtotalT_{\text{total}} is the total project time, tit_i is the time for each task, and NN is the total number of tasks.

- Derivative Calculations:

- **Rate of Task Completion:** $$ \frac{dT}{dt} $$

▪·Where TT is the number of completed tasks, and tt is the time.

Design Methodologies

•□Integral Calculations:

- Total Resource Allocation: $$ R = \int_0^T r(t) \, dt $$

▪·Where RR is the total resource allocation, and r(t)r(t) is the resource allocation rate over time TT.

- Derivative Calculations:

- Rate of Design Completion: $$ \frac{dD}{dt} $$

▪·Where DD is the design progress, and tt is the time.

Management Practices

•□Integral Calculations:

- **Total Cost:** $$
C_{\text{total}} = \int_0^T
c(t) \, dt $$

▪·Where CtotalC_{\text{total}} is the total cost, and c(t)c(t) is the cost over time TT.

- Derivative Calculations:

- Rate of Cost Increase:
$$ \frac{dC}{dt} $$

▪·Where CC is the cost, and tt is the time.

Smart Grids and IoT Applications

Smart Grid Technology

•□Integral Calculations:

- **Total Energy Savings:**

$$ E_{\text{total}} = \int_0^T \left( E_{\text{conventional}} - E_{\text{smart}} \right) \, dt $$

▪·Where EtotalE_{\text{total}} is the total energy savings, EconventionalE_{\text{conventional}} is the energy consumption of conventional grids, and EsmartE_{\text{smart}} is the energy consumption of smart grids.

- Derivative Calculations:

- Rate of Energy Consumption: $$ \frac{dE}{dt} $$

▪·Where EE is the energy consumption, and tt is the time.

IoT in Electrical Systems

•□Integral Calculations:

- **Total Data Collected:**

$$ D_{\text{total}} =
\int_0^T d(t) \, dt $$

▪·Where DtotalD_{\text{total}} is the total data collected, and d(t)d(t) is the data collection rate over time TT.

- Derivative Calculations:

- **Rate of Data Transmission:** $$ \frac{dD}{dt} $$

▪·Where DD is the data collected, and tt is the time.

Overview of wireless communication systems, historical developments, and contemporary applications:

- Historical Developments:

- From Marconi's first transatlantic radio transmission to modern cellular networks.

•□Contemporary Applications:

- Smartphones, IoT devices, satellite communications, and Wi-Fi networks.

29.3 Radio Frequency Fundamentals

Exploration of radio frequency (RF) spectrum, key RF principles, and their application in wireless communication:

- RF Spectrum:

- Allocation of frequencies for different communication services.

•□Key RF Principles:

- Frequency, wavelength, and their relation: $$ \lambda = \frac{c}{f} $$ Where λ\lambda is the wavelength, cc is the speed of light, and ff is the frequency.

29.4 Wireless Signal Propagation

Understanding the behavior of wireless signals over various media and environments, including path loss, fading, and interference:

- Path Loss:

| | |
|---|---|
| | ○ Free-space path loss calculation: $$ PL = 20 \log_{10}\left(\frac{4\pi d f}{c}\right) $$ Where PLPL is the path loss, dd is the distance, ff is the frequency, and cc is the speed of light. |
| | |
| | •□Fading: |
| | |

- Types of fading: multipath, shadowing, and Doppler effect.

- Interference:

- Sources and mitigation techniques.

29.5 Multiple Access Techniques

Survey of multiple access schemes including FDMA, TDMA, CDMA, and OFDMA, which enable multiple users to share the same frequency band:

•□FDMA (Frequency Division Multiple Access):

- Dividing the frequency band into distinct channels.

•□TDMA (Time Division Multiple Access):

- Dividing the time into slots for different users.

•□CDMA (Code Division Multiple Access):

- Using unique codes for each user to share the same frequency band.

•□OFDMA (Orthogonal Frequency Division Multiple Access):

- Subdividing the frequency band into orthogonal sub-carriers.

29.6 Wireless Networking and Protocols

Introduction to wireless network design, including protocol layers, network architectures, and routing protocols:

- Protocol Layers:

- Understanding the OSI model and TCP/IP stack.

•□Network Architectures:

- Cellular, ad hoc, mesh, and hybrid networks.

- Routing Protocols:
  - AODV, DSR, and OLSR.

## 29.7 Cellular Systems and 5G

In-depth analysis of cellular network architecture, with a focus on the evolution from 1G to 5G, and future trends:

•□1G to 4G Evolution:

- Analog to digital, increased data rates, and enhanced services.

•□5G Technology:

| |
|---|
| ○ Enhanced mobile broadband (eMBB), massive machine-type communications (mMTC), and ultra-reliable low-latency communications (URLLC). |
| |
| •□Future Trends: |

- 6G, AI in telecommunications, and beyond.

## 29.8 Antenna Theory and Design

Integral and Derivative Calculations in Antenna Theory:

•□Integral Calculations:

- **Radiation Pattern Integration:** $$ P_{\text{rad}} = \int_0^{2\pi} \int_0^\pi U(\theta, \phi) \sin \theta \, d\theta \, d\phi $$ Where PradP_{\text{rad}} is the total radiated power, U(θ,ϕ)U(\theta, \phi) is the radiation intensity, and θ\theta and ϕ\phi are the spherical coordinates.

- Derivative Calculations:

- **Antenna Gain:** $$ G(\theta, \phi) = \frac{dU(\theta, \phi)}{dP_{\text{in}}} $$ Where G(θ,ϕ)G(\theta, \phi) is the antenna gain, U(θ,ϕ)U(\theta, \phi) is the radiation intensity, and PinP_{\text{in}} is the input power.

Understanding the Basic Concepts of Social Media Marketing

Social media marketing involves using platforms like Facebook, Instagram, Twitter, LinkedIn, and TikTok to promote products, services, or brands. The goal is to engage with potential customers, build relationships, and drive traffic to websites or online stores.

Here's a breakdown of some key concepts:

**1. Audience Engagement:**

•□Integral Calculations:

- **Total Engagement:** $$
E_{\text{total}} = \int_0^T
E(t) \, dt $$

| | |
|---|---|
| | ▪·Where EtotalE_{\text{total}} is the total engagement over time TT, and E(t)E(t) is the engagement rate at time tt. |
| | |
| 2. Content Reach: | |
| | |

- Derivative Calculations:

- **Rate of Reach:** $$
\frac{dR}{dt} $$

▪·Where RR is the reach, and tt is the time.

3. Conversion Rates:

•□Integral Calculations:

- **Total Conversions:** $$
C_{\text{total}} = \int_0^T
C(t) \, dt $$

▪·Where CtotalC_{\text{total}} is the total conversions over time TT, and C(t)C(t) is the conversion rate at time tt.

An introduction to the fundamentals of television and radio production, focusing on skills necessary for creating high-quality media content.

Key Topics:

Television Production Basics

Camera Operation and Techniques:

•□Integral Calculations:

- **Total Recording Time:**

$$ T_{\text{recording}} =
\int_0^N t_i \, di $$

| | |
|---|---|
| ▪·Where TrecordingT_{\text{recording}} is the total recording time, tit_i is the time for each segment, and NN is the number of segments. | |
| | |
| Lighting and Sound Design: | |
| | |

•□Integral Calculations:

- **Total Light Exposure:**

$$ E_{\text{light}} =
\int_0^T L(t) \, dt $$

| |
|---|
| ▪·Where ElightE_{\text{light}} is the total light exposure, L(t)L(t) is the light intensity over time TT. |
| |
| Directing and Producing TV Segments: |
| |

- Derivative Calculations:

- **Rate of Scene Transition:** $$ \frac{dS}{dt} $$

▪·Where SS is the number of scene transitions, and tt is the time.

Radio Production Basics

Audio Recording and Editing:

•□Integral Calculations:

- **Total Audio Duration:**

$$ T_{\text{audio}} =
\int_0^N t_i \, di $$

▪·Where TaudioT_{\text{audio}} is the total audio duration, tit_i is the time for each audio clip, and NN is the number of clips.

Scriptwriting for Radio Broadcasts:

- Derivative Calculations:

- **Rate of Script Progress:**

$$ \frac{dW}{dt} $$

▪·Where WW is the number of words written, and tt is the time.

Hosting and Interviewing Techniques:

•□Integral Calculations:

- Total Interview Duration: $$ T_{\text{interview}} = \int_0^N t_i \, di $$

▪·Where TinterviewT_{\text{interview}} is the total interview duration, tit_i is the time for each interview, and NN is the number of interviews.

## Advanced Production Skills

**Multi-Camera Setups and Live Broadcasting:**

•□Integral Calculations:

- Total Camera

**Coverage:** $$
C_{\text{total}} = \int_0^T
C(t) \, dt $$

▪·Where CtotalC_{\text{total}} is the total camera coverage, and C(t)C(t) is the camera coverage at time TT.

Post-Production Editing and Special Effects:

- Derivative Calculations:

- Rate of Editing

**Progress:** $$ \frac{dE}{dt}
$$

▪·Where EE is the amount of editing completed, and tt is the time.

Integrating Graphics and Animations:

•□Integral Calculations:

- **Total Animation Duration:** $$ T_{\text{animation}} = \int_0^N t_i \, di $$

▪·Where TanimationT_{\text{animation}} is the total animation duration, tit_i is the time for each animation, and NN is the number of animations.

Production Software

•□ **Main Research Area**: Electrical Power Systems & Rural Energy
•□**Key Topics**:
  ○ Stability of power systems
  ○ Low-energy systems for rural applications

- Trade theory and practical aspects in electrical engineering

Industrial electronics and power 2

Curriculum & Course Framework

2.1 Course Title

•□Master of Science in Electrical Engineering (MSEE)

2.2 Terminal Objective

•□Enable students to **define,**

•□rrian professionals in

**electrostatic, electrodynamic**

- Improve **industrial power efficiency** and **renewable energy integration**.

2.3 Brief Description

- Study of **power systems** and their **control**.
- Advanced **electrical stability concepts**:
  - **Electrostatic & electromagnetic**
  - **Synchronization vs. quantum mechanics**
- **Industrial Electronics & Circuit Theory**:
  - **Low-voltage systems**
  - **Stress, rupture, and failure analysis**

- Load-shedding and power system optimization

2.4 Course Activities

- Hands-on experimental work:
  - Electrical system analysis & simulation
  - Value-based analysis of power distribution
  - Stability & synchronization testing
- Practical Assignments:
  - Electrostatic tests and conductivity experiments
  - Dynamic system simulations
  - Evaluation of low-voltage stability
- Case Studies:
  - City Power, Eskom, Schneider Electric

- Load-shedding effects on industrial systems

- 
- Integration of AI and digital control in electrical
- Develop **innovative** solutions for energy
- Enhance **power system efficiency** and **stability**

- **Research Objective**:

- Evaluate **low-energy solutions** for industrial and domestic application

## 3 Research Topics & Case Studies

### 3.1 Research Problem & Justification

- **Problem Statement**:
  - Poor energy distribution efficiency in [illegible]
  - Limited access to [illegible]
  - Stability issues in **low-energy transmission**
- **Justification**:

- High energy demand in industrial and domestic
- Increasing need for **affordable, sustainable**

- AI & automation integration in **power grid control**.

3.2 Case Studies

- Power Stability & Load-Shedding (South Africa's Eskom)
- Renewable Energy in Rural Areas
- Digital Control in Power Management (Smart Grids)

•□AI-based Optimization for Power Systems

## 4 Assessment & Evaluation Criteria

### 4.1 Academic Evaluation (AIU Standards)

•□Knowledge Areas:

- o Electrical engineering principles
- o Trade theory and business applications in
- o Industrial power system development

- Methods:
  - Questionnaires and
  - Videoconferencing
    assessments
  - Experimental lab tests

4.2 Assignment Components

- Title Page: Engineering
  Electrical Master's Research
- Index & Research Structure
- Diagrams & Comparative
  Metrics
- Practical Examples & Case
  Studies
- Regional & Global Energy
  Perspectives

- Advantages & Disadvantages of Energy Systems

## 5 Suggested Topics for Master's Thesis in Electrical Engineering

### 5.1 Power Systems & Energy

| | |
|---|---|
| | •□Power Systems Stability & Control<br>•□Load-Shedding & Energy Distributions & Air-based Power<br>•□Low-Voltage Power Distribution in Developing |
| | •□Integration of Renewable Energy into the Power Grid |
| | |
| 5.2 Telecommunications & Signal Processing | |
| | |

- Digital Telephony & Advanced Telecommunications

6 Conclusion & Next Steps

- Finalize the specific research area:
  - Do you want to focus on [redacted]?
- Develop Research Methodology:
  - Will you conduct experimental work, case
- Refine Key Research Questions:
  - What are the core technical challenges?

- How does **trade theory** influence electrical engineering solutions?

Next Steps for You

- Which specific area do you
- Do you need help designing a
- Would you like experimental
- Wireless communication
- Neural Networks & AI in
- Optical Fiber communication &

- Stochastic Processes in Power Systems

5.3 Industrial & Computational Electrical Engineering

- Digital Control Systems &
- Electromagnetic Waves
- Industrial Power Systems &

- Parallel Computing in Electrical System Simulations

-

Calculus & Integral Formulas in Power Systems and Telecommunications

# 1 Power Systems & Energy – Calculus Applications

## 1.1 Power System Stability & Control

- **Objective**: Ensure stable voltage and frequency across the
- **Key Equations & Integral Formulas**:
  - **Swing Equation (Generator Stability)**:
    - $M$: Inertia
    - $D$: Damping
    - $P_m$: Mechanical input
    - $P_e$: Electrical output

- Integral Form for Power Angle Stability:
$\int_{\delta_0}^{\delta_c} \frac{d\delta}{\sqrt{2H(P_m - P_e(\delta))}} = t$
$\int_{\delta_0}^{\delta_c} 2H(P_m - P_e(\delta))$

.2 Load-Shedding & Energy Distribution in Rural Areas

- **Objective**: Balance demand and supply by controlling power
- Key Equations & Integral Formulas:
  - Load Demand Function (using integral energy
    - LLL: Total energy
    - P(t)P(t)**P(t)**: Instantaneous power at time ttt
  - Load-Shedding Optimization Integral:

▪·C(Pd,Ps)C(P_d,

▪·Used in load-shedding algorithms to **minimize system disruption**.

## 1.3 Smart Grids & AI-based Power System Management

•□**Objective**: Optimize power flow using AI and automation.

•□Key Equations & Integral Formulas:

8. Optimal Power Flow (OPF) Equation:

▪·Used in **grid voltage**

8. Neural Network-Based Load Forecasting

- $y$: Actual power load
- $f(x;\theta)$: Predicted load
- Minimization ensures accurate demand forecasting.

---

## 1.4 Low-Voltage Power Distribution in Developing Countries

- **Objective**: Ensure stable voltage in decentralized power
- **Key Equations & Integral Formulas**:
  - Voltage Drop Equation (Integral Form)
    - $V_{drop}$: Voltage drop
    - $I(x)$: Current flow

- AAA: Conductor cross-sectional

8. Energy Loss in Transmission:

- Helps in designing efficient transmission lines.

## 1.5 Integration of Renewable Energy into the Power Grid

- Objective: Optimize integration of solar, wind, and hydro energy
- Key Equations & Integral Formulas:

8. Solar Power Output Integral:

- Psolar(t)P_{solar}(t): Power at time ttt
- Used for energy

8. Wind Power Equation:

- ρ\rhoρ: Air density
- AAA: Swept area of wind

▪·vv**v**: Wind velocity

## 2 Telecommunications & Signal Processing – Calculus Applications

### 2.1 Digital Telephony & Advanced Telecommunications

- **Objective**: Model and optimize signal transmission.
- **Key Equations & Integral Formulas**: Fourier Transform (Signal Decomposition):

▪·Converts signals from time

8. Convolution Integral (Filtering Signals):

▪·Used in **audio processing and telecommunication filtering**.

## 2.2 Wireless Communication & Signal Transmission

•□**Objective**: Optimize signal transmission over long distances.

•□Key Equations & Integral Formulas:

8. Signal Power Integral (Average Power):

▪·Determines the **power efficiency**

8. Path Loss Integral
(Signal Attenuation Over

▪ CCC: Path loss coefficient

▪ nn: Distance from the

▪ nnn: Path loss exponent

Summary & Next Steps

1 Key Takeaways

✓ Power Systems & Energy

- Integral calculus is used to analyze power stability, load

✓ Telecommunications & Signal

•□Calculus is fundamental for **signal transformation, filtering, and wireless transmission analysis**.

2 Next Steps for You

Integral Formulas and Their Derivations

Integration is a fundamental concept in calculus, focusing on finding a function whose derivative matches a given function. This process is essential for calculating areas under curves, among other applications. Below is a curated list of common integral formulas along with their derivations:

## 1. Basic Integration Formulas

- **Power Rule**: $\int x^n \, dx = \frac{x^{n+1}}{n+1} + C$ (for $n \neq -1$)
  *Derivation*: This
- **Exponential Function**: $\int e^x \, dx = e^x + C$
  *Derivation*: Since the
- **Reciprocal Function**: $\int (1/x) \, dx = \ln|x| + C$

- *Derivation* : The derivative of ln|x| is 1/x, hence its integral is ln|x|.

2. Trigonometric Integrals

- **Sine Function:** $\int \sin(x)\,dx = -\cos(x) + C$ *Derivation* : The
- **Cosine Function:** $\int \cos(x)\,dx = \sin(x) + C$ *Derivation* : The
- **Secant Squared Function:** $\int \sec^2(x)\,dx = \tan(x) + C$

- *Derivation* : The derivative of tan(x) is $\sec^2(x)$.

3. Integration Techniques

- **Integration by Parts**: $\int u\,dv = uv - \int v\,du$
- **Trigonometric Substitution**: Used for integrals involving $\sqrt{a^2}$

- *Derivation* : This is derived from the product

- *Example* : For $\int dx/\sqrt{(a^2 - x^2)}$, use $x = a \sin(\theta)$, leading to the integral $\int d\theta = \theta + C$, and substituting back gives $\arcsin(x/a) + C$.

For a comprehensive list of integral formulas and their derivations, refer to the Integral Calculus Formula Sheet by Ohio State University.

# Bibliography on Power Systems and Energy in Rural Areas

Access to reliable energy is crucial for the development of rural areas. Below is a selection of scholarly works focusing on power systems and energy solutions tailored for rural communities:

## 1. Off-Grid Energy Provision

- **Title**: "Off-grid energy provision in rural areas: an overview of the
  - *Authors* : Terry Van Goyalt
  - *Summary* : This paper

o Link: Off-grid energy provision in rural areas

**2. Renewable Energy Strategies in Sub-Saharan Africa**

- Title: "Is a PV-led renewable energy strategy the right
  - *Authors* : S. Karekezi, W. Kithyoma
  - *Summary* : This article

o Link: Is a PV-led renewable energy strategy the right approach?

3. Rural Electrification in India

- **Title**: "Rural electrification in India and feasibility of
  - *Authors* : [Authors not specified]
  - *Summary* : This study

- o Link: Rural electrification in India

**4. Renewable Energy Systems in Indonesia**

- **Title**: Renewable energy systems based on micro hydro
  - *Authors* : Kamaudin Syahputra
  - *Summary* : This case

o Link: Renewable energy systems in Yogyakarta

These resources offer valuable insights into the challenges and solutions associated with providing energy to rural areas, highlighting both technological approaches and policy considerations.

Recent Developments in Rural Energy Solutions

that integrate hardware configuration
with electrical engineering principles:

Background on Microsoft Hardware Configuration

1. Data Centers and Server Hardware:
   - Microsoft Azure data centers utilize custom server configurations focused on power distribution.
2. IoT Hardware Solutions:
   - Microsoft's IoT devices, like Azure IoT Edge, integrate seamlessly with electrical
3. Surface Devices and Computing Platforms:
   - Microsoft Surface devices leverage advanced chipsets enable computational
4. Smart Power Systems:

- Microsoft uses intelligent hardware configurations in its operations, enabling advanced load management and energy optimization for devices and servers.

To integrate calculation derivations and integral applications across the outlined software and hardware experimental areas, let’s explore how mathematical modeling enhances efficiency and performance:

Integral and Derived Calculations for Software and Hardware

1. Software Calculations

- **Performance Optimization Algorithms:**
  - Derive optimal response times by

- Energy Efficiency Modeling:
  - Measure the energy consumption for software
- System Compatibility Simulation:
  - Simulate system performance compatibility using integral-based statistical models: $$\text{Compatibility Score} = \int_{x_{1}}^{x_{n}} \text{Performance Deviation}(x) \, dx$$

2. Hardware Calculations and Materials

- Sustainability in Hardware Design:
  - Evaluate energy efficiency using integrals: $$\text{Energy Efficiency} = \int_{t_{1}}^{t_{2}} \text{Power Consumption}(t) \, dt$$
- Thermal Management in Data Centers:
  - Derive cooling efficiency: $$\text{Heat
- IoT Device Material Optimization:

- Analyze material stress under environmental conditions by integrating force over surface area: $$\sigma = \frac{\int F \, dA}{A_{total}}$$ This evaluates device durability.

Experimental Topics with Integral Derivations

AI Algorithm Efficiency

•□**Experiment:** Quantify Azure AI tools' computational energy for

| |
|---|
| ○ Evaluate power efficiency during model training. |
| |
| Cloud Resource Allocation |
| |

| |
|---|
| •□**Experiment:** Calculate energy savings with dynamic resource optimization: $$\text{Energy Savings} = \int_{t_1}^{t_2} \big(P_{peak}(t) - P_{optimized}(t)\big) \, dt$$ |
| |
| Windows OS Compatibility Simulation |
| |

•□**Experiment:** Determine compatibility trends across hardware configurations: $$\text{Trend Function} = \int_{Config_1}^{Config_n} \text{Compatibility Index}(x) \, dx$$

Applications Across Microsoft Hardware Configuration

1. Data Centers and Server Hardware:
   - Integral Derivation for Power Distribution:
2. IoT Hardware Solutions:
   - Real-Time Data Processing:
3. Surface Devices and Efficiency:

- Battery Consumption
**Analysis:** $$\text{Battery Lifetime} = \int_{t_1}^{t_2} \frac{Capacity}{P_{device}(t)} \, dt$$

Experimental Topics in Electrical Engineering and Microsoft Hardware

1. **Energy Efficiency in Azure Data Centers**
   - **Experiment:** Analyze
   - **Focus:** Measure the
2. **IoT Integration for Smart Grid Systems**

- **Experiment:** Study how
- **Focus:** Test or enabled
3. **Battery Performance in**
- **Experiment:** Evaluate
- **Focus:** Compare the
4. **Heat Dissipation in Electrical**
**Components**
- **Experiment:** Investigate
- **Focus:** Test underlying
5. **Sustainability of Smart Power**
**Systems**
- **Experiment:** Explore
- **Focus:** Simulate
6. **Compatibility of Hardware**
**with Electrical Engineering**
- **Experiment:** Assess the
- **Focus:** Measure compliance and reliability in real-world applications.

-

1.18.1Cisco, as a global leader in networking, cybersecurity, and IT solutions, offers a wealth of opportunities for career development and experimental research. Here's a structured overview of Cisco's career-focused initiatives and potential experimental topics:

Background on Cisco Careers

1. **Networking Expertise:**
   - Cisco is renowned for its leadership in
   - Professionals often build their careers around
2. **Cybersecurity Leadership:**
   - Careers at Cisco often involve roles in
   - Training and certifications such as
3. **Collaboration and Cloud Solutions:**
   - Cisco's collaboration tools (e.g., Webex) and
4. **Focus on Innovation:**
   - Cisco invests heavily in innovation, such as AI
5. **Global Training Programs:**
   - Cisco Networking Academy (NetAcad) offers

- The academy supports educational institutions, fostering a steady pipeline of skilled professionals.

Experimental Topics

1. **Impact of Cisco Certifications on Career Progression**
   - **Focus:** Study how Cisco certifications affect job opportunities and career advancement.
   - **Experiment:** Survey certified professionals to analyze their career growth.
2. **Adoption of Cisco's Collaboration Tools in Remote Learning**
   - **Focus:** Analyze how educational institutions use Cisco's collaboration tools for online education.
   - **Experiment:** Conduct a case study comparing student engagement and learning outcomes.
3. **Role of AI in Network Automation**
   - **Focus:** Explore how Cisco's AI-driven solutions are transforming network management.
   - **Experiment:** Simulate network configurations using Cisco's AI tools and measure efficiency improvements.
4. **Cybersecurity Skills and Threat Management**
   - **Focus:** Investigate the effectiveness of Cisco's cybersecurity training programs in preparing professionals for real-world threats.
   - **Experiment:** Assess the knowledge retention and practical skills of participants through simulated cyber attack scenarios.
5. **Diversity in Cisco Networking Academy**
   - **Focus:** Evaluate how Cisco Networking Academy addresses diversity and inclusion in its programs.
   - **Experiment:** Analyze demographic data and participation rates to identify trends and areas for improvement.

6. IoT and Career Skills Development
   - Focus: Study how Cisco's IoT training
   - Experiment: Assess skill
7. Environmental Sustainability in Cisco Careers
   - Focus: Analyze how Cisco's emphasis on
   - Experiment:

isco is a powerhouse in networking, security, and IT solutions, making it an essential subject for exploring hardware calculations, configurations, and their applications in electrical engineering. Here's a breakdown of the background and experimental topics related to Cisco hardware and electrical systems:

Background on Cisco Hardware and Configuration in Electrical Engineering

1. **Networking Hardware:**
   - Cisco's routers,
   - These devices play a
2. **Power and Energy Management:**
   - Cisco integrates smart
   - Electrical engineers use configurations like PoE
3. **IoT Solutions:**
   - Cisco IoT hardware
   - These devices are
4. **System Design and Configuration:**
   - Cisco hardware
   - Electrical engineers
5. **Energy Efficiency and Sustainability:**
   - Cisco incorporates

- This aligns with global goals for sustainability in electrical and networking systems.

Experimental Topics

**Hardware Calculations**

**1. Efficiency of Power Over Ethernet (PoE) Systems**

- **Experiment:** Test
- **Focus:** Assess power delivery efficiency for

**2. Load Balancing in Electrical Grids**

- **Experiment:** Analyze
- **Focus:** Measure system stability and efficiency

**3. Heat Dissipation in Cisco Hardware**

- **Experiment:** Study the thermal management

- **Focus:** Test different cooling configurations and materials.

Hardware Configuration

4. Optimization of IoT-Enabled Electrical Systems
   - **Experiment:** Configure Cisco IoT hardware for automation with traditional
   - **Focus:** Compare
5. Network Traffic Impact on Energy Consumption
   - **Experiment:** Measure the correlation between
   - **Focus:** Simulate high
6. Compatibility of Cisco Devices with Electrical Standards
   - **Experiment:** Test Cisco hardware configurations

- **Focus:** Ensure compliance and reliability under diverse conditions.

Electrical System Integration

7. Smart Grid Performance with Cisco Hardware
   - **Experiment:** Investigate the role of Cisco
   - **Focus:** Study how configurations improve
8. Renewable Energy Integration
   - **Experiment:** Configure Cisco hardware to

- **Focus:** Analyze the efficiency of hardware configurations in hybrid energy setups.
  -

ISC² (International Information Systems Security Certification Consortium) focuses on cybersecurity career advancement, offering world-renowned certifications and exams for professionals in the field. Here's a structured background and experimental topics related to ISC² security, careers, and certifications:

Background on ISC² Security Career Certifications

1. Prominent Certifications:
   - CISSP (Certified Information Systems Security Professional):
     - Recognized as the gold standard
     - Focused on cybersecurity leadership
     - Target audience: experienced professionals
   - CCSP (Certified Cloud Security Professional):
     - Specializes in cloud security
     - Target audience: cloud professionals
   - SSCP (Systems Security Certified Practitioner):
     - Focused on practical skills
     - Target audience: entry-level professionals
   - CSSLP (Certified Secure Software Lifecycle Professional):
     - Specializes in secure software development
     - Target audience: software developers
2. Exam Structure and Content:
   - Exams typically include multiple-choice questions

- Topics are based on ISC²'s **Common Body of**
3. Career Impact:
   - ISC² certifications open doors to high-demand
   - Professionals with certifications often enjoy
4. Global Reach and Training:
   - ISC² offers training materials, study guides
   - The certifications are respected globally, making them valuable for building international careers.

Experimental Topics Related to ISC²
Security and Careers

1. Impact of ISC² Certifications on Career Progression
   - **Experiment:** Analyze
   - **Focus:** Survey
2. Exam Preparation Techniques and Success Rates

- **Experiment:** Evaluate the effectiveness of
- **Focus:** Compare the
3. **Certification Adoption in Small vs. Large Organizations:**
   - **Experiment:** Study how small businesses
   - **Focus:** Track how certified staff contribute
4. **Skills Acquired Through Certification:**
   - **Experiment:** Investigate the practical application
   - **Focus:** Assess the implementation of risk
5. **Cloud Security Knowledge Through CCSP Certification:**
   - **Experiment:** Explore how CCSP certified ability
   - **Focus:** Identify specific
6. **Diversity and Accessibility in ISC² Certification Programs:**
   - **Experiment:** Analyze demographic trends
   - **Focus:** Identify steps ISC² could take to
7. **Global Demand for Cybersecurity Certifications:**
   - **Experiment:** Examine the geographic
   - **Focus:** Highlight areas of high certification adoption versus emerging markets.

background experimental isc certificate calculation

ISC² certifications, such as CISSP, CCSP, and SSCP, require a solid understanding

Background on ISC² Certificate Calculation Needs

1. Risk Assessment and Management:
    - ISC² certifications emphasize risk management, so calculations may involve quantifying risks, assessing vulnerabilities, and determining the likelihood and impact of security incidents.
2. Resource Allocation in Security Operations:
    - Tasks include calculating the Return on Investment (ROI) for security measures, determining the efficient allocation of resources, and optimizing budgets for security initiatives.
3. Cryptography and Key Management:
    - Encryption methods are crucial in ISC² certifications, so calculations may involve key length determination, encryption/decryption processes, and assessing the strength of cryptographic algorithms.
4. Security Metrics and Performance Evaluation:
    - Certified professionals often calculate various security metrics to evaluate the performance of security controls, incident response times, and overall security posture. These metrics are critical in monitoring and improving security effectiveness.
5. Cloud Security Calculations:
    - For certifications like CCSP, candidates must understand cloud-specific security challenges, so calculations may involve assessing cloud service models, evaluating cloud security risks, and implementing cloud security controls.

Experimental Topics related to ISC² Certificate Calculations in Business Making

1. Evaluating the Accuracy of Risk Assessments:
    - **Focus:** Assess how well ISC² certified professionals can accurately identify and quantify risks in various scenarios.
    - **Experiment:** Simulate different risk scenarios and measure the accuracy of risk assessments made by participants.
2. Optimization of Resource Allocation Using ROSI:
    - **Focus:** Study the effectiveness of Return on Security Investment (ROSI) calculations in resource allocation decisions.
    - **Experiment:** Measure the efficiency of resource allocation before and after implementing ROSI calculations.
3. Cryptographic Performance Analysis:
    - **Focus:** Investigate the efficiency of ISC² certified cryptographic algorithms in different computing environments.
    - **Experiment:** Test the performance of various encryption algorithms under different workloads.
4. Application of Cloud Security Calculations:
    - **Focus:** Analyze the impact of cloud security calculations on business operations.
    - **Experiment:** Compare cloud security metrics before and after implementing cloud-specific security controls.
5. Quantifying Security Metrics for System Resilience:
    - **Focus:** Study how well ISC² certified professionals can quantify and improve system resilience.
    - **Experiment:** Track security metrics over time and measure improvements in system resilience.
6. Vulnerability Scoring and Patch Prioritization:
    - **Focus:** Explore how vulnerability calculation

- **Experiment:** Evaluate system security before and after implementing prioritized patches.

The convergence of electrical engineering, hardware systems, and data security presents a compelling field of study under the umbrella of ISC (Information Systems and Cybersecurity). Below is a structured background overview and potential experimental topics at this intersection:

Background on ISC, Electrical Hardware, and Data Security

**1. Electrical Hardware in IT and Data Systems**

- Electrical hardware like
- Hardware security and IoT
- Applications include
- Electrical grids,
- Cybersecurity
- Power management in
- Electrical systems in

**2. Data Security in Electrical Systems**

**3. Interdependencies in Electrical and IT Systems**

4. ISC² and Electrical Systems:

- ISC² certifications, such as CISSP (Certified Information Systems Security Professional) or CCSP (Certified Cloud Security Professional), include knowledge areas covering hardware and infrastructure security, ideal for professionals working with electrical and data systems.

Experimental Topics

Electrical Hardware and Data Security

1. Securing Power Distribution in Data Centers
   - **Experiment:** Analyze the effectiveness of
   - **Focus:** Simulate potential vulnerabilities in
2. IoT Device Vulnerabilities in Electrical Networks
   - **Experiment:** Investigate encryption
   - **Focus:** Test encryption and secure boot in
3. Energy-Efficient Cryptographic Hardware

- **Experiment:** Design and test cryptographic
- **Focus:** Compare energy efficiency and computational performance of different encryption techniques.

Electrical Systems and Cyber Threat Detection

4. Anomaly Detection in Industrial Control Systems
   - **Experiment:** Develop
   - **Focus:** Evaluate IDS
5. Cybersecurity Frameworks for Smart Grids
   - **Experiment:** Analyze the implementation of

- **Focus:** Measure the impact of applied frameworks on grid stability and data integrity.

Integration of Hardware, Electrical Systems, and Security

6. Resilience Testing of Electrical Hardware
   - **Experiment:** Test the durability and survivability of [illegible] against [illegible]
   - **Focus:** Assess tamper-resistant designs and [illegible]
7. Hardware-based Security for Renewable Energy Systems
   - **Experiment:** Investigate the role of hardware

- **Focus:** Compare hardware reliability and data protection efficiency across various renewable setups.

4. Anomaly Detection in Industrial Control Systems

Developing hardware-based IDS (Intrusion Detection Systems) involves

1. **Signal Processing and Filtering:**
   - Use integration to
   - For example, calculate the cumulative energy
2. **Threshold-Based Detection:**
   - Derive anomalies by integrating deviations
3. **Accuracy Evaluation Metrics:**

- Evaluate IDS accuracy using ROC (Receiver Operating Characteristic) curves, which involve integral calculations to determine areas under the curve (AUC) for false positive/negative rates: $$\text{AUC} = \int_{x_{false}}^{x_{true}} f(x) \, dx$$

5. Cybersecurity Frameworks for Smart Grids

Analyzing the implementation of ISC security principles in smart grids involves

1. **Grid Stability Analysis:**
   - Integrate power flow
2. **Encryption and Data Security Metrics:**
   - Measure encrypted data efficiency via integral
3. **Framework Impact on Integrity:**
   - Assess the cumulative impact of security
4. **Grid Communication Latency:**

| |
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| ○ Integrate latency values across communication nodes to optimize response times: $$\int_{node_1}^{node_n} \text{Latency}(x) \, dx$$ Where Latency(x)\text{Latency}(x) represents transmission delays at node xx. |
| |

Salesforce, a leader in CRM (Customer Relationship Management), along with Trailblazer learning programs and Tableau data analytics tools, provides exciting avenues for experimentation and innovation. Here's an overview and experimental topics:

Background on Salesforce and Trailblazer

1. Salesforce CRM Ecosystem:
   - Salesforce CRM is used for various
   - Features tools like Sales Cloud, Marketing Cloud
2. Trailblazer Learning Program:
   - Trailhead, Salesforce's learning platform
   - Focuses on gamified learning and personalized
3. Tableau Analytics:
   - Salesforce Tableau enables advanced data

- Widely used across industries like finance, healthcare, and retail for business intelligence.

Experimental Topics

Salesforce CRM Focus

1. Personalized Customer Engagement Algorithm
   - **Experiment:** Test Salesforce's Adriven
   - **Focus:** Measure the effectiveness of
2. Sales Workflow Optimization
   - **Experiment:** Study how Salesforce tools

- **Focus:** Measure reductions in lead conversion time and effort.

Trailblazer Learning Program

3. Effectiveness of Gamified Learning
   - **Experiment:** Analyze the impact of Trailhead's
   - **Focus:** Compare results with traditional learning
4. Skill Progression with Trailhead Certifications
   - **Experiment:** Evaluate career advancements

- **Focus:** Measure employment and salary growth over time.

Tableau Analytics

5. Impact of Data Visualization on Decision-Making
   - **Experiment:** Investigate how Tableau dashboards influence rates of decisions
   - **Focus:** Compare
6. Integration of Tableau with Salesforce CRM
   - **Experiment:** Study how the integration improves
   - **Focus:** Track ROI driven predictive analytics
7. Efficiency of AI Analytics in Tableau
   - **Experiment:** Analyze the accuracy and insights

- **Focus:** Measure prediction reliability on business trends and outcomes.

### 1.20.1 Background on Salesforce Training and Products

1. **Salesforce Training Ecosystem:**
   - **Trailhead Learning Platform:** Offers gamified
   - **Corporate Training Programs:** Organizations
2. **Tableau Analytics Integration:**
   - Tableau is a part of Salesforce and specializes
   - Training in Tableau covers topics like data
3. **Industry Applications:**

- Salesforce and Tableau serve industries such as finance, healthcare, retail, and technology. Training programs often focus on tailoring solutions to meet sector-specific needs, such as customer journey mapping or real-time analytics.

Experimental Topics

**Training Programs**

1. **Effectiveness of Gamification in Trailhead**
   - **Experiment:** Measure the impact of Trailhead's
   - **Focus:** Compare
2. **Skill Advancement from Certifications**
   - **Experiment:** Evaluate how Trailblazer

- **Focus:** Track skill utilization in real-world Salesforce product implementations.

Product Integration

3. Impact of Salesforce-Tableau Integration on CRM Analytics
   - **Experiment:** Study how Tableau dashboards change in CRM
   - **Focus:** Monitor
4. Data Visualization in Marketing Campaigns
   - **Experiment:** Assess the effectiveness of Tableau

- **Focus:** Compare ROI and campaign efficiency for visualized vs. non-visualized strategies.

Product Performance and Innovation

5. AI-driven insights in Tableau Analytics
   - **Experiment:** Analyze the accuracy and usability
   - **Focus:** Measure
6. Customization of Salesforce Tools for Industry-Specific
   - **Experiment:** Develop tailored Salesforce

- **Focus:** Study ease of adoption and operational enhancements from tailored setups.

Background on Salesforce, Trailblazer, and Tableau

1. **Salesforce Ecosystem:**
   - Salesforce is a leading CRM platform offering
   - It supports advanced **configurations** enabling
2. **Trailblazer Program:**
   - **Trailhead Learning Platform** delivers
   - Certifications from Trailhead cover Salesforce
3. **Tableau Analytics:**
   - Tableau excels in data visualization and
   - Widely used for analyzing hardware
4. **Electrical Hardware and System Relevance:**
   - Salesforce and Tableau can integrate with IoT

- Through automation workflows, Salesforce tools can manage the lifecycle of electrical assets, while Tableau visualizes their performance trends.

Configuration and Calculation Examples

**1. Electrical Load Management:**

- **Salesforce Configuration:**
  - Use Salesforce IoT integration to monitor real-time load data from smart meters.
  - Automate workflows to trigger alerts for system overloads.
- **Tableau Visualization and Calculation:**

- Create dashboards to visualize electrical load distribution: $$\text{Total Load} = \int_{t_1}^{t_2} P(t) \, dt$$ Where P(t)P(t) represents power usage over time.

2. Data Integration for Fault Detection:

- Salesforce Configuration:
  - Configure Salesforce
  - Create reports to track historical fault
- Tableau Analytics:
  - Analyze fault trends using Tableau's machine

- Calculate fault impact:

$$\text{Impact Score} = \int_{t_1}^{t_2} \big(F_{severity}(t) \cdot F_{duration}(t)\big) \, dt$$

3. Energy Efficiency Optimization:

- Salesforce Automation:
  - Automate processes to manage energy saving
- Tableau Analysis:

- Measure energy savings: $$\text{Energy Saved} = \int_{t_1}^{t_2} \big(P_{initial}(t) - P_{optimized}(t)\big) \, dt$$ This tracks power consumption before and after optimization efforts.

Experimental Topics

1. **Salesforce and IoT for Electrical Hardware Monitoring:**
   - Experiment with integrating Salesforce IoT data for real-time and automated
2. **Tableau in Energy Efficiency Analysis:**
   - Explore how Tableau dashboards can improve
   - Experiment with interpreting predictive
3. **Skill Training via Trailhead for Smart Systems:**
   - Analyze how Trailhead training improves the

| |
|---|
| ○ Experiment with measuring skill acquisition rates versus project outcomes. |
| |

1.21.1 The Metropolitan Police Service (Met Police) in the UK is one of the most prominent law enforcement agencies, and experimental studies in policing, governance, and technology implementation offer numerous possibilities. Here's a detailed background and potential research topics focusing on "block marks," which may refer to policing strategies, community markers, or system blockages in law enforcement operations:

Background on the Met Police UK

1. Law Enforcement Mission:
   - The Met Police
   - The organization works closely with community
2. Technology Integration:
   - The Met Police has
   - Blocked operations or system inefficiencies are
3. Community Engagement:
   - Programs focus on building trust between
4. Operational Challenges:
   - Budget constraints, resource allocation, and

- "Block marks" could symbolize procedural or systemic blockages, including administrative hurdles, data flow interruptions, or social challenges like distrust in policing.

Experimental Topics

Technology Implementation

1. **Effectiveness of Predictive Policing Models**
   - **Experiment:** Evaluate how predictive algorithms
   - **Focus:** Measure the
2. **Body-Worn Cameras and Trust Building**
   - **Experiment:** Assess the
   - **Focus:** Compare
3. **Data Flow Blockage in Law Enforcement**
   - **Experiment:** Investigate the causes and impacts of

- **Focus:** Propose solutions for seamless information sharing across units.

Community Engagement

4. Community Perception of Police Presence
   - **Experiment:** Study how
   - **Focus:** Compare areas
5. Addressing Distrust through Restorative Practices
   - **Experiment:** Examine

- **Focus:** Track recidivism and satisfaction rates post-program implementation.

Operational Effectiveness

6. Resource Allocation in High-Density Blocks
   - **Experiment:** Test strategies for optimizing patrol routes and response times.
   - **Focus:** Analyze crime rates and officer deployment.
7. Policing Blockages in Emergency Response
   - **Experiment:** Evaluate the impact of

- **Focus:** Implement process improvements and measure performance changes.

The Metropolitan Police Service (Met Police) in the UK plays a crucial role in law enforcement, community safety, and professional career development. Exploring their training programs and career paths provides meaningful insights into law enforcement innovation. Below is a structured background and potential experimental topics related to Met Police careers, training, and the concept of "blockmark," which may relate to operational blocks, procedural benchmarks, or performance indicators:

Background on Met Police Training and Careers

1. Career Development:
   - The Met Police offers a range of entry points for career progression, involves specialized roles
2. Training Programs:
   - Comprehensive training is provided at the public's cost.
   - Key areas include
3. Operational Benchmarks ("Blockmarks"):
   - Blockmarks may refer to procedural standards
   - These benchmarks ensure accountability
4. Use of Technology:
   - Advanced technology, like data analytics and AI

- Training programs now incorporate technological skills to prepare officers for modern challenges.

Experimental Topics

Training Programs

1. **Effectiveness of Simulation-Based Training**
   - **Experiment:** Compare
   - **Focus:** Assess retention
2. **Evaluation of Community Policing Training**
   - **Experiment:** Study how
   - **Focus:** Compare trust
3. **Career Progression and Training Accessibility**
   - **Experiment:** Investigate

- **Focus:** Analyze how diversity and inclusion policies impact training outcomes and promotions.

Operational Blockmarks

4. **Performance Metrics in Crime Prevention**
   - **Experiment:** Study the effectiveness of
   - **Focus:** Track crime
5. **Technology Training Impact on Performance**
   - **Experiment:** Evaluate the impact of training
   - **Focus:** Measure
6. **Blockmarks for Officer Well-Being**
   - **Experiment:** Test the inclusion of mental health

- **Focus:** Analyze changes in job satisfaction and performance among officers.

These topics provide opportunities to explore the effectiveness of Met Police training programs, blockmark benchmarks, and their impact on officer careers and community

The Metropolitan Police Service (Met Police) in the UK utilizes a combination of advanced hardware, software, and data systems to enhance its operations, and exploring their configurations and calculations in this context can reveal opportunities for optimization. Here's a structured background and experimental ideas for calculations, sizing, and configurations involving the Met Police's use of data, hardware, and software systems.

Background on the Met Police's Use of Technology

1. Hardware Systems:
   - Key Infrastructure:
     - IoT and Sensors:
     - Scaling and Sizing:
2. Software Systems:
   - Data Management
   - Predictive Policing:
   - Configuration
3. Data Utilization:
   - Operational Data:
   - Analysis and

- **Security Compliance:** Ensures adherence to
- Balancing hardware scalability with cost
- Configuring software systems to adapt to
- Ensuring interoperability among devices and platforms.

4. Challenges and Opportunities:

Experimental Topics

Hardware Configuration and Sizing

1. Optimizing Server Capacity for Crime Data Management
   - **Experiment:** Determine the optimal number of
   - **Calculation:** Use data from
2. IoT Network Sizing for Urban Surveillance
   - **Experiment:** Analyze the capacity of IoT

Software Configuration and Data Analysis

- **Focus:** Evaluate team-
- **3: Energy Efficiency in Computation**
- **Beam Hardening Experiment:** Investigate the power consumption
- **6: Visualizing Uninterrupted Data Ion**
- **Detector Alignment Experiment:** Assess the impact of data
- **4: Crime Prediction Accuracy in**
- **Software Experiment:** Test
- **6: Calculation Uncertainty:** Measure
- **3: Optimizing Software Wouldn't Know**
- **Configuration Experiment:** Study How
- **6: Focus:** Quantitative
- **6: Visualizing Uninterrupted Data Ion**
- **Detector Alignment Experiment:** Assess the impact of data

- **Focus:** Compare energy usage under normal and peak loads to identify inefficiencies.

- **Focus:** Compare planning outcomes with and without visualization tools.

Data System Integration

7. Interoperability of Hardware and Software Platforms
   - **Experiment:** Analyze the compatibility of
   - **Focus:** Test data flow
8. Scaling Data Storage for Long-Term Investigations
   - **Experiment:** Determine

- **Calculation:** Predict future storage needs: $$\text{Future Storage} = \int_{t_0}^{t_{future}} \text{Data_{input}}(t) \, dt$$

The integral calculations embedded within the experimental topics related to hardware systems, software systems, and data utilization offer insightful opportunities for precision and optimization in the Met Police's operational environment. Here’s how these integrals would apply, along with specific examples tailored for electrical engineering relevance:

Integral Calculations for Hardware Systems

**1. Optimizing Server Capacity for Crime Data Management**

- **Key Integral:** $$\text{Capacity} = \int_{t_1}^{t_2}
- **Application:** This integral calculates the

- **Electrical Engineering Perspective:** Ensures that server hardware power consumption is optimized, avoiding overloading or underutilization of storage systems.

2. IoT Network Sizing for Urban Surveillance

- **Key Integral:** $$\text{Network Load} = \int_{t_1}^{t_2}
- **Application:** Analyzes the total volume of data

- **Electrical Engineering Perspective:** Ensures bandwidth allocation in networked surveillance systems aligns with power supply and scalability requirements.

3. Energy Efficiency in Control Room Hardware

- **Key Integral:** $$\text{Energy Consumption} = \int_{t_1}^{t_2}
- **Application:** Evaluates the energy consumed by

- **Electrical Engineering Perspective:** Helps design efficient electrical systems to minimize energy wastage during peak operations.

Integral Calculations for Software Systems

1. Crime Prediction Accuracy

- **Key Integral:** $$\text{Accuracy} = \int_{t_1}^{t_2}
- **Application:** Calculates the deviation between

- **Electrical Engineering Perspective:** Informs power requirements for running predictive algorithms efficiently on computational hardware.

2. Optimizing Software Workflow Configurations

- **Key Integral:** $$\text{Workflow Efficiency} = \int_{t_1}^{t_2}
  - **Application:** Measures how effectively workflows

- **Electrical Engineering Perspective:** Helps configure power redundancy in electrical setups supporting critical software applications.

3. Visualizing Crime Data for Decision-Making

- **Key Integral:**
  $$\text{Visualization Impact} = \int_{\text{Data Collection}}^{\text{Decision Making}} \text{Clarity of Insights} \, dt$$
  - **Application:** Quantifies improvements in decision

- **Electrical Engineering Perspective:** Optimizes energy efficiency of display systems used for visualization.

Integral Calculations for Data System Integration

**1. Interoperability of Hardware and Software Platforms**

- **Key Integral:** $$\text{Data Flow Continuity}

- **Application:** Monitors error rates across

- **Electrical Engineering Perspective:** Enhances fault tolerance in interconnected electrical and data systems.

2. Scaling Data Storage for Long-Term Investigations

- **Key Integral:** $$\text{Future Storage} = \int_{t_0}^{t_{future}}
- **Application:** Predicts storage requirements for

| |
|---|
| ○ **Electrical Engineering Perspective:** Ensures electrical infrastructure scalability for high-capacity data servers. |
| |

1.22.1 The Department of Higher Education and Training (DHET) in South Africa oversees various education and training initiatives, including NATED and NCV programs, as well as institutions accredited by SAQA (South African Qualifications Authority) and QCTO (Quality Council for Trades and Occupations). Here's a structured background and experimental topics in education and career development:

Background on DHET and Associated Entities

1. **DHET (Department of Higher Education and Training)**
   - Responsible for post-school education and training.
   - Focuses on developing skills for employment.
2. **NATED (National Accredited Technical Education Diploma)**
   - Designed for TVET (Technical Vocational Education and Training) colleges.
   - Offers vocational education for trades.
   - Equips learners with skills for specific trades.
3. **NCV (National Certificate Vocational)**
   - Responsible for ensuring qualifications

- Accredits providers of education and training.
- Focuses on developing occupational

3. QCTO (Quality Council for Trades and Occupations)

- Ensures training is relevant to industry demands and promotes skills transferability.

Experimental Topics

Education and Training

1. Effectiveness of NATED Programs in Industry Readiness
   - **Experiment:** Study how NATED graduates
   - **Focus:** Analyze employability rates and
2. New Learner Satisfaction and Career Trajectory
   - **Experiment:** Evaluate the satisfaction levels of
   - **Focus:** Compare career progression
3. Impact of SAQA Accreditation on TVET Colleges
   - **Experiment:** Assess the influence of SAQA

- **Focus:** Examine learner performance and progression rates.

Occupational and Career Development

4. Role of QCTO in Developing Workplace-Relevant Skills
   - **Experiment:** Analyze the effectiveness of QCTO alignment through
   - **Focus:** Measure of QCTO
5. Career Pathways through Vocational Qualifications
   - **Experiment:** Investigate the comparative
   - **Focus:** Comparative of
6. Digital Integration in Vocational Training
   - **Experiment:** Explore how digital tools enhance

- **Focus:** Evaluate improvements in student engagement and practical skill development.

Innovative Areas for Exploration

**1. Blended Learning Models for TVET Colleges**

- Experiment with hybrid approaches that combine online

**2. Sustainability in Vocational Curricula**

- Develop

**3. Community Impact of DHET-Funded Initiatives**

| |
|---|
| ○ Examine how vocational qualifications address unemployment rates and improve local economies. |
| |

The Department of Higher Education and Training (DHET) in South Africa oversees various education and training initiatives, such as NATED (National Accredited Technical Education Diploma) and NCV (National Certificate Vocational) programs, as well as qualifications certified by SAQA (South African Qualifications Authority) and QCTO (Quality Council for Trades and Occupations). Combining these with data configuration, training, and engineering (particularly electrical engineering) creates exciting opportunities for educational and professional exploration. Here's a comprehensive overview and experimental ideas:

Background on DHET Education, Career Pathways, and Technical Training

**1. DHET and Vocational Education:**

- DHET drives post-school education and skill
- Programs like NATED (N1-N6) and NCV (Level 2
- Focuses on bridging the skills gap in South Africa

**2. SAQA-Accredited Qualifications:**

- SAQA aligns qualifications with the
- Electrical engineering qualifications emphasize

**3. QCTO's Role in Occupational Training:**

- The QCTO emphasizes
- Electrical engineering
- Training and the QCTO

**4. Engineering and Electrical Systems:**

- Electrical engineering
- Topics like electrical
- Modern education

**5. Data Configuration in Education and Industry:**

- Engineering industries rely on data systems to optimize design, configuration, and operational processes.

Experimental Topics

NATED and NCV Programs in Electrical Engineering

1. **Effectiveness of Practical Training in NATTD Programs**
   - **Experiment:** Evaluate how practical sessions in problem-solving skills in
   - **Focus:** Compare
2. **Skills Transferability in NCV Graduates**
   - **Experiment:** Assess the ability of NCV graduates
   - **Focus:** Analyze
3. **Digital Tools for Learning Enhancement**
   - **Experiment:** Explore how integrating
   - **Focus:** Compare learning effectiveness between traditional lab setups and digital simulations.

Let’s explore how integral calculations and derivations play a crucial role in the educational and practical contexts outlined for DHET programs, particularly in electrical engineering, with NATED, NCV, and SAQA/QCTO frameworks. Here’s a breakdown of the calculations and their applications within these phases:

## Integral Calculations in Engineering Education

### 1. Load Analysis in Electrical Training

- **Key Calculation:** Determining the total electrical load in
  - $P(t)P(t)$: Power consumption at time $t$

- **Application:** Students calculate real-world power demands in circuits, developing practical design skills.

2. Circuit Design and Efficiency

- **Key Calculation:** Calculating energy efficiency ($\eta = \frac{P_{output}}{P_{input}} \times 100\%$).
  - $P_{output}$: Useful power output.
  - $P_{input}$: Total power input.

- **Application:**
Emphasizes practical understanding of energy conservation in renewable energy projects.

3. Simulation of Renewable Energy Systems

- **Key Calculation:** Modeling

- **Application:** Students use software to simulate solar or wind energy contributions to grid systems.

Integral Calculations in Data Configuration

**1. Curriculum Optimization Using Data**

- **Key Calculation:** Tracking curriculum success:

- **Application:** Data analytics evaluate how students perform on theoretical and practical modules over time.

2. Resource Allocation in TVET Labs

- **Key Calculation:** Optimizing resource usage: $$\text{Resource

- **Application:** Predicts material or lab equipment needs based on student interactions.

Integral Derivations for Engineering Systems

1. Electrical Circuit Phase Calculations

- **Derivation:** Determine phase angles in alternating current (AC)
  - $v(t)$: Voltage as a function of time
  - $i(t)$: Current as a function of time

- **Application:** Enhances learners' grasp of real-time analysis for AC systems.

2. Heat Dissipation in Electrical Systems

- **Derivation:** Evaluate system safety through thermal modeling.
  - $i(t)$: Current through the system.
  - RR: Resistance.

- **Application:** Helps students learn to prevent overheating in engineering applications.

Experimental Integration into NATED and NCV Programs

**Effectiveness of Practical Training in NATED Programs**

| | |
|---|---|
| | •□**Experiment:** Measure students improvement in efficiency |
| | •□**Focus:** Compare their problem-solving rates in controlled theoretical versus simulated environments. |
| | |
| Skills Transferability in NCV Graduates | |
| | |

| |
|---|
| •□**Experiment:** Study how students transition to advanced renewable energy projects after completing calculations like: $$\text{Renewable Efficiency} = \frac{\int_{t_1}^{t_2} P_{renewable}(t) \, dt}{\int_{t_1}^{t_2} P_{total}(t) \, dt}$$ |
| |
| Digital Tools for Learning Enhancement |
| |

| |
|---|
| •□**Experiment:** Evaluate the role of software simulations in building students’ circuit design skills, using integrals for load analysis. |
| |

1.23.1 Sci-Bono Discovery Centre and Kheta both play crucial roles in South Africa's educational landscape, aligning with the DHET's (Department of Higher Education and Training) mission to promote skills development, particularly through NATED and NCV programs. Here's a structured background and experimental career-oriented topics linked to these initiatives:

Background on Sci-Bono and Kheta

1. Sci-Bono Discovery Centre:
   - A flagship science
   - works in collaboration
   - It provides practical
2. Kheta Career Guidance Initiative:
   - An online and mobile
   - focuses on aligning
   - Offers information on
3. NATED (National Accredited Technical Education Diploma):
   - A program designed for
   - Levels N1–N6 prepare
4. NCV (National Certificate Vocational):

- A vocational alternative to traditional secondary

- Career-oriented, equipping learners with workplace-ready skills.

Experimental Topics

Sci-Bono's Role in Skills Development

1. **Impact of Sci-Bono Workshops on Career Readiness**
   - **Experiment:** Evaluate the effectiveness of Sci-
   - **Focus:** Compare
2. **Effectiveness of Sci-Bono's Technical Exhibits**
   - **Experiment:** Study how technical exhibits

- **Focus:** Analyze exhibit engagement rates and resulting career choices.

Kheta Career Guidance Initiative

3. Role of Kheta in Career Decision-Making
   - **Focus:** Track learner satisfaction and
4. Digital Career Counseling for NGV Learners
   - **Experiment:** Assess the influence of Kheta's

- **Focus:** Compare job placement rates among users of Kheta's platform versus traditional counseling methods.

NATED and NCV Programs

5. Workplace Integration of NATED Graduates
   - **Experiment:** Study how well NATED learners
   - **Focus:** Measure employer feedback and
6. Skills Transfer in NCV Vocational Graduates
   - **Experiment:** Examine how NCV graduates apply

- **Focus:** Analyze adaptability to emerging technology-based trades.

Innovative Areas for Exploration

1. Digital Learning Modules for NATED and NCV
   - Develop online training modules tailored to STEM
2. Sustainability Education Integration
   - Pilot eco-conscious learning programs in Sci
3. Career Mentorship Programs

- Investigate the effectiveness of mentorship initiatives facilitated by Kheta and Sci-Bono in accelerating career readiness.

bacground experimental configuration
material background experimental
sciebono kheta DHET’s NATED and NCV
programs career topics

Exploring Sci-Bono, Kheta, and DHET's NATED and NCV programs together offers a powerful perspective on education, technical training, and career development in South Africa. Below is a detailed background overview and experimental ideas that focus on configuration, materials, and career topics linked to these initiatives:

Background on Sci-Bono, Kheta, DHET NATED, and NCV Programs

1. Sci-Bono Discovery Centre:
   - Sci-Bono is a prominent hub for STEM education
   - The center frequently collaborates with DHET to
2. Kheta Career Guidance:
   - Kheta is a digital platform
   - It offers resources to help students understand
3. NATED Programs:

- These are structured
- focuses on managing
theoretical knowledge

4. NCV Programs:

- An alternative to
- NCV combines
- Both NATED and NCV
programs emphasize

3. Engineering and Materials
Configuration:

- Learners develop skills in system design, configuration, and troubleshooting, addressing material properties and energy efficiency.

Experimental Topics

Sci-Bono Discovery Centre

1. Impact of Sci-Bono Technical
Workshop Experiment:

- **Experiment:** Study how
- **Focus:** Compare skills
development in workshop

2. STEM Exhibit Engagement

- **Experiment:** Analyze how engagement with Sci

- **Focus:** Track the career choices of learners exposed to STEM-focused activities.

Kheta Career Guidance

3. Effectiveness of Kheta's Career Path Tools

- **Experiment:** Evaluate the success of Kheta's
- **Focus:** Compare decision-making and

4. Kheta's Role in NCV Job Placement

- **Experiment:** Assess how Kheta resources

- **Focus:** Track placement rates and employer feedback.

NATED and NCV Career Topics

5. Material Configuration Skills in NATED Programs

- **Experiment:** Investigate how NATED learners
- **Focus:** Measure proficiency in core

6. Adaptability of NCV Graduates in Emerging Industries

- **Experiment:** Study the ability of NCV graduates

- **Focus:** Analyze their skills in implementing modern configurations.

Integration of Configuration and Materials

1. Engineering Material Simulation
   - Use computer-aided tools to simulate the
2. Digital Training Modules
   - Incorporate digital modules for configuring
3. Sustainable Material Practices

| | |
|---|---|
| | ○ Pilot an NCV curriculum focused on integrating sustainable materials into engineering projects. Evaluate learner understanding of eco-friendly design. |
| | |

Integral and derived calculations can provide meaningful insights into the Sci-Bono workshops, Kheta career tools, and DHET's NATED and NCV programs, especially when addressing engineering configuration and materials. Let’s explore integral and derived calculations applied to these contexts:

Integral Calculations in Engineering and Education

1. Engineering Material Efficiency in Workshops

•□**Calculation:** $$\text{Material Efficiency} = \frac{\int_{t_1}^{t_2}

- **Application:** Sci-Bono workshops can use this integral to teach learners how to optimize material usage in engineering designs.

2. Energy Consumption in Configuration Exercises

- **Calculation:** $$\text{Energy Consumed} = \int_{t_1}^{t_2} P(t) \, dt$$
  - $P(t)$: Power usage of electrical configurations

- **Application:** Helps learners in NATED programs understand the total energy requirements of different system setups during practical sessions.

3. Success Metrics for Career Tools

- **Calculation:** $$\text{Career

- **Application:** Kheta can use this formula to assess how well their career tools align with learners' aspirations and labor market demands.

Derived Calculations in Engineering Systems

1. Thermal Management in Electrical Systems

- **Key Derivation:** $$Q = \int_{t_1}^{t_2} I^2(t) \cdot R \
  - QQ: Heat generated in a circuit

- **Application:** Learners in NCV programs can calculate heat dissipation to design safer electrical systems.

2. Load Analysis in Material Simulation

- **Key Derivation:** $$\text{Stress} = \frac{F}{A}$$
  - $F$: Force applied
  - $A$: Cross-sectional area of the material

- **Application:** Used in Sci-Bono material configuration exercises to teach stress analysis in engineering.

Experimental Focus Areas Incorporating Integrals

Sci-Bono Workshops:

1. Engineering Material Simulation
   - **Experiment:** Evaluate
   - **Calculation:**
2. Energy Optimization in Electrical Circuits
   - **Experiment:** Compare

- **Calculation:**

$$\text{Energy Saved} = \int_{t_1}^{t_2} \big(P_{traditional}(t) - P_{optimized}(t)\big) \, dt$$

Kheta Career Tools:

3. Effectiveness of Digital Career Guidance **Experiment:** Assess how Kheta's career tools

- **Calculation:**

$$\text{Decision Accuracy} = \int_{t_1}^{t_2} \frac{\text{Correct Career Matches}}{\text{Total Recommendations}} \, dt$$

NATED and NCV Programs

**1. Practical Skills Retention**

- **Experiment:** Study retention rates of learners exposed to

•□**Calculation:** $$\text{Skill Retention} = \int_{t_1}^{t_2} \text{Learner Performance}(t) \, dt$$

2. Material Sustainability Practices

•□**Experiment:** Pilot sustainable material use in engineering

| |
|---|
| •□**Calculation:**<br>$$\text{Sustainability Index} = \frac{\int_{t_1}^{t_2} \text{Eco-friendly Material Usage}(t) \, dt}{\int_{t_1}^{t_2} \text{Total Material Usage}(t) \, dt}$$ |
| |

Integrals and derived equations provide measurable insights into the design, optimization, and educational outcomes of Sci-Bono and Kheta initiatives while enhancing the career preparedness offered by DHET's NATED and NCV programs. Let me know if you'd like to refine these concepts further!

1.24.1 The synergy between Kheta career tools, DHET's NATED and NCV programs, and entities such as SETA (Sector Education and Training Authorities), MERSETA (Manufacturing, Engineering and Related Services SETA), SASSETA (Safety and Security Sector Education and Training Authority), INSETA (Insurance Sector Education and Training Authority), and SAQA (South African Qualifications Authority) fosters an ecosystem of skill development and career growth. Here's an overview and experimental topics that explore their impact and potential:

Background on Kheta, DHET, NATED and NCV, and Related Entities

1. **Kheta Career Tools:**
   - An innovative digital
   - Offers tools for career
   - Plays a key role in
2. **DHET (Department of Higher Education and Training):**
   - Oversees post-school
   - NATED focuses on
3. **SETA (Sector Education and Training Authorities):**

- SETAs are mandated to promote skills
- Examples include:
  - MERSETA:
  - SASSETA:
  - INSETA:
- Dedicated to
- Supports skills in
- Ensures the quality and standardization of

4. SAQA (South African Qualifications Authority):

- Works with DHET, SETAs, and industry stakeholders to align education with occupational and professional needs.

Experimental Topics

Kheta Career Tools and Digital Guidance

1. Effectiveness of Career Path Tools

- **Focus:** Track participation rates in vocational careers linked to platform guidance.

NATED and NCV Programs

- **Focus:** Analyze graduates' performance in non-traditional sectors.

SETA-Funded Training and Impact

5. Alignment of SETA-Funded Programs with Industry Needs
   - **Experiment:** Study how SETAs fund and measure training programs.
6. Impact of Workplace-Based Learning
   - **Experiment:** Analyze the role of workplace

- **Focus:** Compare outcomes between participants in SETA apprenticeships and classroom-only learning.

SAQA-Accredited Qualifications

7. Quality Assurance in Vocational Education
   - **Experiment:** Examine how SAQA's standards

- **Focus:** Compare learner achievement and employer satisfaction across SAQA-accredited programs.

Innovative Integrations and Opportunities

**1. Digital Training Modules Across Sectors**

- Develop modules combining Khato's career

**2. Sustainable Practices in Engineering Programs**

- Pilot green engineering curricula in NATED and

**3. Cross-SETA Collaboration**

| |
|---|
| ○ Study the impact of integrating expertise across MERSETA, SASSETA, and INSETA for multidisciplinary skills development. |
| |

ntegrals and derived calculations play a key role in exploring the applications of Kheta, DHET's NATED and NCV programs, and SETA initiatives, particularly in the field of electrical engineering. Below are experimentally driven calculations tailored to these areas:

Integral Calculations for Electrical Engineering Applications

1. Practical Skill Development in NATED Programs

•□**Calculation:** Energy
consumption during practical

- P(t)P(t): Power utilized by equipment during

- **Application:** Evaluates energy efficiency in electrical systems created by NATED learners.

2. Load Balancing in Electrical Circuits

- **Calculation:** $$\text{Total Load} = \int_{t_1}^{t_2} I(t)V(t) \, dt$$
  - I(t)I(t): Current over time

- **Application:** Helps learners understand electrical load distribution in circuits, fostering practical configuration skills.

3. Thermal Management in Electrical Components

- **Calculation:** Heat dissipation in components $$Q =
  - I(t)I(t): Current.
  - RR: Resistance.

- **Application:** Prepares students to design systems that prevent overheating in electrical circuits.

Derived Equations in Engineering Training

**1. Renewable Energy System Simulation for NCV Graduates**

- **Derived Formula:** Efficiency of solar panels: $$\text{Efficiency} =

- **Application:** NCV programs can use this derivation to train learners on optimizing renewable energy systems.

2. Fault Current Calculations for Safety Training

- **Derived Formula:** $$I_{fault} = \frac{V_{source}}{Z_{system}}$$
  - $V_{source}$: System voltage.
  - $Z_{system}$: System impedance.

- **Application:** Used to teach safety and fault detection in SASSETA-accredited programs.

3. Stress Testing in Material Configuration

- **Derived Formula:** Stress in load-bearing materials, $$\sigma =
  - FF: Force.
  - AA: Cross-sectional area

- **Application:** MERSETA learners can apply this in projects involving mechanical and electrical materials.

Experimental Topics Using Calculations

**1. Effectiveness of Practical Configurations in NATED**

- **Experiment:** Test practical designs created by learners

•□**Calculation:** Compare actual and simulated energy consumption: $$\text{Error} = \int_{t_1}^{t_2} \big| P_{simulated}(t) - P_{actual}(t) \big| \, dt$$

2. Alignment of SETA-Funded Training with Industry Needs

•□**Experiment:** Evaluate workplace systems designed by

•□**Focus:** Measure load distribution accuracy and system longevity based on given configurations.

3. Adaptability to Emerging Fields in NCV Programs

•□**Experiment:** Analyze graduates ability to apply configurations to

•□**Calculation:** Measure response times and energy savings in smart circuits: $$\text{Optimization Ratio} = \frac{\int_{t_1}^{t_2} \text{Output Energy Efficiency}(t) \, dt}{\int_{t_1}^{t_2} \text{Input Energy}(t) \, dt}$$

1.25.1 The connection between DHET (Department of Higher Education and Training), NATED and NCV programs, the DTIC (Department of Trade, Industry, and Competition) Council, engineering education, and QCTO (Quality Council for Trades and Occupations) offers a robust framework for skills development and career readiness in South Africa. Here's a detailed background and experimental topic ideas to explore their impact:

Background

1. **DHET and TVET Education:**
   - DHET oversees technical and vocational education across TVET colleges.
   - **NATED (National Accredited Technical Certificate Vocational):**
   - **NCV (National Certificate Vocational):**
2. **DTIC Council:**
   - The DTIC promotes industrialization with collaboration with DHET for programs aligning
3. **Engineering and Skills Development:**
   - Engineering training through NATED and NCV
   - The DTIC supports initiatives to enhance
4. **QCTO (Quality Council for Trades and Occupations):**
   - Ensures occupational qualifications are

- Plays a pivotal role in developing engineering-related qualifications that meet industry standards.

Experimental Topics

NATED and NCV Programs

1. Workplace Readiness in NATED Engineering Programs
   - **Focus:** Measure adaptation to workplace
   - **Experiment:** Evaluate how NATED engineering
2. Adaptability of NCV Graduates
   - **Experiment:** Investigate how NCV graduates

- **Focus:** Track their ability to implement new technologies and processes.

DTIC-Aligned Engineering Innovations

3. Impact of Industry Partnerships on Engineering

- **Focus:** Measure learner engagement in hiring critical
- **Experiment:** Assess how DTIC

4. STEM Awareness Initiatives by DTIC and DUET

- **Experiment:** Study the effectiveness of STEM

- **Focus:** Compare pre- and post-campaign participation in technical fields.

QCTO Occupational Qualifications

**3. Competency-Based Learning Effectiveness**

- **Experiment:** Analyze
- **Focus:** Compare
- **Experiment:** Investigate

**6. Industry Integration of QCTO Graduates**

- **Focus:** Measure their impact on productivity and innovation in their workplaces.

Innovative Ideas for Exploration

1. **Digital Modules for Engineering Training:**
   - Develop online simulations for experiment with enhanced skill
2. **Sustainable Materials in Engineering Projects:**
   - Pilot eco-friendly engineering projects with
   - Evaluate graduate readiness for green
3. **Cross-Institution Collaboration:**
   - Foster cooperation between DUFT, DTIC, and

| |
|---|
| ○ Experiment with programs that integrate advanced technologies such as robotics or IoT. |
| |

Material configuration, system sizing, and integral calculations can significantly enhance experimental approaches within the outlined framework of NATED and NCV programs, DTIC-aligned initiatives, and QCTO occupational qualifications. Here's a detailed breakdown of how calculations contribute to these experiments:

Integral Calculations for Engineering Experiments

1. Workplace Readiness in NATED Programs

- **Key Calculation:** Energy use in industrial scenarios for graduate
  - $P(t)P(t)$: Power
- **Application:** Evaluates how efficiently NATED

- **Key Calculation:** Load distribution in circuit
  - $I(t)P(t)$: Current flow over time
  - **Application:** Assesses learners' proficiency in designing balanced and efficient circuits.

2. Adaptability of NCV Graduates

- **Key Calculation:** Renewable energy utilization ratio
  - $\frac{P_{output}(t)}{P_{input}(t)}$:
  - $P_{input}(t)$: Total energy supplied

- **Application:** Tracks how well graduates adapt their skills to emerging technologies like solar or wind power systems.

3. STEM Awareness and Industry Partnerships

- **Key Calculation:** Enrollment growth rate in STEM programs;

- **Application:** Quantifies the impact of DTIC-supported campaigns on increasing STEM participation.

Derived Calculations in Electrical Configuration

1. Thermal Management in Component Sizing

- **Formula Derivation:** Heat dissipation in electrical systems:
  - $I(t)$: Current, $R$: Resistance

- **Application:** Helps learners size components like heat sinks to ensure safe and efficient operations.

2. Load Stress Analysis in Mechanical Design

- **Derived Formula:** Stress in materials: $$\sigma =
  - FF: Force applied.
  - AA: Cross-sectional area

- **Application:** MERSETA apprenticeships can use this formula for structural engineering and load-bearing studies.

3. Fault Current Evaluation

- **Formula Derivation:** Fault current in circuits: $I_{fault} = \frac{V_{source}}{Z_{total}}$.
  - $V_{source}$: Source voltage

- **Application:** SASSETA learners practice detecting and mitigating faults in safety-critical systems.

Experimental Topics and Applications

**Digital Modules for Engineering Training**

- **Experiment:** Compare virtual learning outcomes with hands-on

•□**Calculation:** Learner performance metrics: $$\text{Performance Index} = \int_{t_1}^{t_2} \text{Task Completion}(t) \, dt$$

Sustainable Materials in Engineering Projects

•□**Experiment:** Test eco-friendly materials in NATED or NCV

•□**Calculation:** Material efficiency ratio: $$\text{Efficiency Ratio} = \frac{\int_{t_1}^{t_2} \text{Eco-friendly Output}(t) \, dt}{\int_{t_1}^{t_2} \text{Material Input}(t) \, dt}$$

Industry Integration of QCTO Graduates

•□**Experiment:** Measure

| |
|---|
| •□**Calculation:** Impact analysis: $$\text{Productivity Gain} = \int_{t_1}^{t_2} \frac{\text{Output}*{improved}(t) - *text{Output}* {baseline}(t)}{\text{Time}} \, dt$$ |
| |

1.26.1 e intersection of DHET's (Department of Higher Education and Training) NATED programs, UCPD (Unit for Continuing Professional Development), DTIC (Department of Trade, Industry, and Competition), DTS (Department of Transport Services) regulations, and South Africa's energy sector—including City Power and Eskom—offers innovative opportunities for skills development, education, and operational improvement. Here's a structured breakdown and experimental topics for exploration:

Background

1. DHET and NATED Programs:
   - NATED qualifications (N1–N6) provide technical
   - These programs
2. UCPD (Unit for Continuing Professional Development):
   - UCPD supports ongoing
   - It focuses on upskilling
3. DTIC (Department of Trade, Industry, and Competition):
   - It promotes industrial
   - It works closely with
4. DTS (Department of Transport Services) Regulations:
   - It oversees
   - Energy regulations
5. City Power and Eskom (Energy Sector):
   - City Power:
     Responsible for electricity

- Eskom: South Africa's primary electricity supplier, involved in generation, transmission, and distribution, with an emphasis on managing load shedding and transitioning to renewable energy.

Experimental Topics

DHET and NATED Programs

1. Impact of Practical Training in Energy Systems
   - **Experiment:** Assess how practical modules in [illegible] improve performance in [illegible]
   - **Focus:** Compare [illegible]
2. Integration of Smart Technologies in Education
   - **Experiment:** Investigate the use of IoT-enabled [illegible]

- **Focus:** Measure outcomes in system configuration and troubleshooting exercises.

UCPD and Continuing Development

3. Effectiveness of Professional Development for Engineers
   - **Experiment:** Track how UCPD trainings measurably improve engineers' application
   - **Focus:** Measure
4. Upskilling Professionals for Renewable Energy Transition
   - **Experiment:** Evaluate how continuing education

- **Focus:** Analyze learner adaptability to new technologies.

DTIC and DTS Regulations

3. Industrial Growth Through Energy Partnerships
   - **Experiment:** Assess the impact of DTIC's
   - **Focus:** Track energy efficiency improvements
6. Compliance Training for Transport Systems
   - **Experiment:** Study the effectiveness of DTS

- **Focus:** Measure awareness and adherence among energy professionals.

City Power and Eskom Experimental Topics

7. Energy Load Analysis for Reliability
   - **Experiment:** Simulate load distribution
   - **Focus:** Measure impacts on reliability
8. Renewable Energy Integration with Eskom's Grid
   - **Experiment:** Analyze the integration of wind

- **Focus:** Compare power stability and efficiency before and after renewable energy integration.

Innovative Ideas for Exploration

1. Digital Modules for NATED Programs:
   - Develop online modules focusing on
   - Collaborate between UCPD and Eskom to
2. Energy Transition Research:
3. Cross-Departmental Collaboration:

| | |
|---|---|
| | ○ Foster partnerships between DHET, DTIC, and DTS to create integrated training programs emphasizing renewable energy’s impact on transport systems. |
| | |

1.27.1 e intersection of DHET’s NATED programs, UCPD, DTIC, DTS regulations, and South Africa’s energy sector (including City Power and Eskom) provides opportunities for advancing engineering education, skills development, and energy-sector innovations. Below, I outline applicable calculations and configuration concepts for experimental topics:

Integral and Derived Calculations for Engineering and Energy Applications

1. Impact of Practical Training in Energy Systems (NATED Programs)

- **Calculation:** Energy consumption during practical training sessions.
  - $P(t) = V(t) \times I(t)$: Power used by equipment.
  - $V(t), I(t)$: Voltage and current flowing through the circuit.
  - **Application:** Helps assess how much energy is consumed during training.
- **Calculation:** Load balancing in training simulations.
  - $I_{total} = \sum_{i=1}^{n} I_i$: Total current in a parallel circuit.
  - **Application:** Evaluates proficiency in designing systems to prevent overloading or inefficiencies.

2. Integration of Smart Technologies (IoT in Education)

- **Calculation:** Data transfer efficiency in IoT-based labs:
  - **Application:** Measures the effectiveness of IoT-enabled labs in simulating real-world system troubleshooting for learners.

3. Renewable Energy Transition (UCPD Programs)

- **Calculation:** Renewable energy system efficiency

- $P_{output}$: Power output.
- $P_{input}$: Total energy supplied.

- **Application:** Assesses learners' abilities to configure energy systems for maximum sustainability.

4. Energy Load Analysis for City Power

- **Calculation:** Peak load during demand cycles, $\int_{t_1}^{t_2} P(t)\,dt$.
- $I(t)$: Current, $V(t)$: Voltage.

- **Application:** Helps City Power optimize grid performance under varying load conditions.

5. Renewable Energy Integration with Eskom’s Grid

- **Calculation:** Stability of integrated renewable sources

- **Application:** Evaluates the ratio of renewable energy contributions to overall grid stability.

Experimental Topics Using Electrical Configurations

1. Load Distribution Simulations

- **Experiment:** Simulate load management strategies for City

•□**Focus:** Compare configurations that minimize energy losses during peak periods.

2. IoT-Enabled Fault Detection

•□**Experiment:** Develop IoT-based

•□**Focus:** Track how quickly learners identify and resolve faults using real-time data.

3. Workforce Upskilling for Sustainable Energy

•□**Experiment:** Evaluate the

•□**Focus:** Measure learner adaptability to renewable energy technologies versus traditional systems.

Innovative Collaborative Opportunities

**1. Digital Training Modules for Energy Regulations**

•□Develop digital content integrating RTS compliance

| | |
|---|---|
| | •□Experiment with learner outcomes in understanding regulatory applications. |
| | |
| 2. Advanced Material Applications | |
| | |

| | |
|---|---|
| | •□Pilot the use of sustainable materials in NATED and UCPD courses, focusing on energy systems such as battery enclosures and smart meters. |
| 3. Multi-Agency Energy Curriculum | |
| | •□Coordinate with DHET, DTIC, and Eskom to develop an |

•Include modules on IoT,
renewable energy configuration,
and grid management simulations.

Integral Calculations for Engineering and
Energy Applications

1. Impact of Practical Training in Energy Systems (NATED Programs)

- **Energy Consumption:** $$\text{Energy Consumed} =
  - **Explanation:** Measures how efficiently NATED
- **Load Balancing in Electrical Circuits:** $$\text{Total Load} =

  - **Explanation:** Assesses learners' ability to design balanced systems that prevent overloads. I(t)I(t) is the current passing through the circuit.

2. Integration of Smart Technologies (IoT in Education)

- Data Transfer Efficiency in IoT Labs: $$\text{Efficiency} =

  - **Explanation:** Evaluates the quality of real-time data management systems used in training labs.

3. Renewable Energy Transition (UCPD Programs)

- Efficiency of Renewable Energy Systems: $$\text{Efficiency} =

- **Explanation:** Measures performance in training scenarios focused on renewable energy optimization. Poutput(t)P_{output}(t) is the energy delivered; Pinput(t)P_{input}(t) is the energy supplied.

4. Energy Load Analysis (City Power)

- Peak Load Calculation:

$$\text{Peak Load} = \max\left(

- **Explanation:** Optimizes load distribution in City Power's grid during demand spikes. I(t)I(t) and V(t)V(t) denote current and voltage.

5. Renewable Energy Integration (Eskom's Grid)

•□Stability of Integrated Energy

**Sources:** $$\text{Stability Index} =

- **Explanation:** Tracks how renewable sources contribute to overall power grid stability.

Experimental Topics for Energy and Educational Systems

1. Load Management Strategies (City Power)

- **Experiment:** Simulate load distribution to optimize energy

•□**Focus:** Compare configurations involving renewable and non-renewable inputs.

2. IoT-Driven Fault Detection Systems

•□**Experiment:** Develop IoT applications for detecting faults in

•□**Focus:** Test learners' response times and the accuracy of system diagnostics.

3. Renewable Energy Skill Development (UCPD)

•□**Experiment:** Evaluate UCPD participants' adaptability in

•□**Focus:** Track skill application and efficiency improvements.

4. Sustainable Material Integration in Curricula

•□**Experiment:** Test new eco-friendly materials in NATED

| |
|---|
| •□**Focus:** Measure system efficiency and graduate readiness to support sustainable energy initiatives. |
| |
| Innovative Collaborative Opportunities |
| |
| **1. Digital Training Modules** |
| |

| | |
|---|---|
| | •□Design online modules for understanding DTS regulations on energy-efficient transport (e.g., EV systems). Analyze learners' regulatory knowledge retention. |
| | |
| 2. Cross-Agency Curriculum Development | |
| | |

| | |
|---|---|
| | •Collaborate between DHET, DTIC, and Eskom to create interdisciplinary programs emphasizing renewable energy and smart grid configurations. |
| | |
| 3. Advanced IoT Configurations | |
| | |

| |
|---|
| •Integrate IoT data analytics into City Power and Eskom training programs to enhance grid monitoring efficiency. |
| |

1.29. Integrating insights from **DHET's NATED programs**, **SARS (South African Revenue Service)**, and **SARB (South African Reserve Bank)** provides a unique lens for exploring education, compliance, and economic stability. Below is a structured background and experimental topics to align these entities effectively:

Background

**DHET (Department of Higher Education and Training):**

- Manages **NATED programs** (N1-N6) and **NCV qualifications**

•□Designed to prepare learners for professional roles and further education, ensuring workforce readiness.

SARS (South African Revenue Service):

•□Responsible for collecting revenue to fund public services

- Collaborates with educational bodies to promote tax literacy among students and professionals.

**SARB (South African Reserve Bank):**

- Focuses on monetary policy, economic stability, and financial

- Plays a role in educating individuals on financial planning, currency stability, and economic impacts on trade.

Experimental Topics

1. DHET and NATED Programs

1. Economic Literacy in NATED Curriculums
   - **Focus:** Study student understanding of CAPS
   - **Experiment:** Integrate basic financial principles
2. NATED Graduates in Financial Roles
   - **Experiment:** Assess career success of NATED

- **Focus:** Compare graduate outcomes in traditional technical roles vs financial roles.

2. Collaboration with SARS

3. Tax Education Workshops for Vocational Students
   - **Experiment:** Pilot workshops and analyze awareness levels and
   - **Focus:** Measure

4. SARS Impact on Startup Growth
   - **Experiment:** Evaluate the role of tax incentives

- **Focus:** Study business survival rates and alignment with tax compliance.

3. SARB and Economic Training

3. Monetary Policy Awareness Among BUET Learners

- **Experiment:** Develop
- **Focus:** Assess how
- **Experiment:**

6. Financial Management Integration

- **Focus:** Track learner proficiency in managing personal and business finances.

Innovative Collaborative Opportunities

1. **Financial Literacy Certifications:**
   - Partner with SARS and SAPP to offer specialized
2. **Cross-Sector Career Alignment:**
   - Collaborate with both SARS and SAPP to align
3. **Digital Tax and Financial Simulations:**

- Introduce virtual tools to simulate tax filing, financial management, and economic planning for students.

- 
-

2. Electrical System Data

- **Power Consumption in Operational Phase:** $P(t) = V(t) \times I(t)$, $P(t)$: Power usage at time $t$
- **Heat Dissipation in Circuits:** $Q = I^2 R t$, $Q$: Heat, $I$: Current, $R$: Resistance, $t$: Time
- **Application:** Calculates energy efficiency of

- **Application:** Prevents overheating in circuits linked to banking machines.

3. Tax and Economic Modules Integration

- **Tax Compliance Simulation:** $\text{Tax Payment} = \text{Income} \times \text{Tax Rate}$
  - **Application:** Educates
- **Inflation and Currency Impact Simulation:** $\text{Current Purchasing Power} = \frac{\text{Initial Amount}}{(1 + \text{Inflation Rate})^{\text{Years}}}$
  - Initial Amount: Initial purchasing power;

- **Application:** Integrates SARB data for learners exploring monetary stability.

Experimental Topics

Machine Configuration and Electrical Engineering

1. Energy Optimization for Bank Note Machines
   - **Experiment:** Test configurations using
   - **Focus:** Reduce costs
2. IoT Integration for Monitoring Machine Efficiency
   - **Experiment:** Apply IoT sensors to track machine

- **Focus:** Improve system reliability through real-time monitoring.

Economic and Tax Awareness

3. Economic Modules in Vocational Curriculums
   - **Focus:** Enhance student understanding of
   - **Experiment:** Introduce interactive tools for
4. SARS Tax Simulation Tools
   - **Experiment:** Integrate
   - **Focus:** Enhance financial

- **Focus:** Educate learners on balancing operational costs and legal obligations.

Innovative Opportunities

1. **Collaborative Development:**
   - Work with SARS and SAPP to create cross
2. **Sustainable Energy Systems:**
   - Partner with Eskom and City Power to
3. **Digital Learning Platforms:**

| |
|---|
| ○ Use simulations and AI to model banking machine productivity and financial impacts for learners. |
| |

The integration of **banknote processing machines, robotics, printers**, ATMs, and **tax and teller systems** combines engineering and financial concepts to improve efficiency, compliance, and user experience. Below is a detailed breakdown of integral and derived calculations, configuration considerations, and their relevance to **SARB (South African Reserve Bank)** and **SARS (South African Revenue Service)**:

## Integral and Derived Calculations in Machine Configuration

### 1. Banknote Processing Machines

- **Material Throughput:**
  $$\text{Throughput Rate} =
  - **Application:** Optimizes the speed and capacity of

- **Error Detection:** $$\text{Error Rate} = \frac{\int_{t_1}^{t_2}

  - **Application:** Improves the accuracy of note scanning systems for counterfeit detection and damaged notes.

2. Robotic Integration in Printers and ATMs

- **Load Balancing for Robotic Arms:** $$\text{Distance} = \times

  - **Application:** Ensures

- **Energy Efficiency in Robotics:** $$\text{Energy Consumed} =

  - Plot (y): Power

- **Application:** Tracks energy usage to optimize robotic efficiency and reduce operational costs.

3. ATMs and Tax Systems

- **Cash Dispensation:**
  $$\text{Cash Dispensed}$$
  - **Application:** Ensures the correct functioning of
- **Transaction Tax Calculation**
  **(for SARS Compliance):**

- **Application:** Helps track tax collection in systems where ATM withdrawals or payments are taxable.

System Configuration and Optimization

1. Machine Calibration

- Printer Configuration for Banknotes:
  - Adjustments must consider:
    - Ink Distribution:
    - Material Alignment:
- Robotics in Sorting Machines:
  - Ensure robots are calibrated to detect:
    - Counterfeits based on weight

▪·Folding or damage that could affect usability.

2. ATM and Teller Machine Configuration

•□Load Distribution in Cash

- **Application:** Prevents overloading and ensures smooth dispensing.

Experimental Topics

1. **Efficiency of SARB-Approved Banking Machines**
   - **Experiment:** Study the [illegible]
   - **Focus:** Analyze [illegible]
2. **Robotic Integration in Financial Automation**
   - **Experiment:** Use [illegible]
   - **Focus:** Measure time[illegible]
3. **Real-Time Tax Deduction via ATMs**
   - **Experiment:** Pilot ATMs that directly calculate and

- **Focus:** Ensure compliance with SARS regulations while simplifying tax processes.

Innovative Solutions

1. **IoT Integration:**
   - Monitor performance of banknote machines
2. **Blockchain in SARB Systems:**
   - Use blockchain to track the lifecycle of banknotes

3. Digital Tax Dashboards:

- 

Ford Motoring Background

1. Industry Legacy:
   - Credited with introducing the assembly
   - Specializes in manufacturing cars
2. Current Innovations:
   - Known for advancements in hybrid

- Implements smart technology, including AI-powered driving assistance, autonomous features, and fuel efficiency optimization.

Calculation Topics for Ford Motoring

1. Fuel Efficiency

- Calculation: Miles Per Gallon (MPG): $$\text{MPG} =

- **Application:** Helps users determine fuel efficiency for cars like the Ford Focus or Explorer, aiding eco-conscious decision-making.

2. Engine Performance

- **Power Output:** $$P = T \cdot \omega$$, where P: Power (watts), T: Torque (Newton-meters),

- **Application:** Used to calculate the performance of Ford's engines, including turbocharged EcoBoost engines.

3. Vehicle Speed

- **Acceleration:** $$a = \frac{\Delta
  - $a$: Acceleration,
  - $\Delta v$: Change in

- **Application:** Measures how quickly vehicles like the Ford Mustang GT can reach top speeds.

4. Electric Vehicle Range

- Energy Consumption:
$$\text{Range} =

- **Application:** Calculates driving range for Ford's electric models like the Mustang Mach-E.

5. Emissions and Sustainability

•□Carbon Emissions:
$$\text{Emissions} =

- **Application:** Tracks environmental impact, allowing Ford vehicles to meet emission standards.

Experimental Topics

1. **Hybrid Engine Efficiency:**
   - **Experiment:** Study the energy [illegible]
   - **Focus:** Compare fuel consumption and electric
2. **Aerodynamic Design Testing:**
   - **Experiment:** Test different hydrocarbons
   - **Focus:** Improve fuel [illegible]
3. **Battery Longevity in Electric Models:**
   - **Experiment:** Analyze battery degradation over

- **Focus:** Evaluate performance improvements with advanced battery chemistry.

caculation ..

Transnet is South Africa's largest freight transportation and logistics company, operating ports, rail networks, pipelines, and related infrastructure. Exploring career opportunities within Transnet alongside **configuration calculations** provides a solid foundation for professional growth in engineering, operations, and business development.

Background on Transnet

1. **Company Overview:**
   - Specializes in freight logistics and operations
   - Plays a key role in driving South Africa's
2. **Career Opportunities at Transnet:**
   - Offers positions in engineering, logistics
   - Encourages professional development
3. **Focus Areas in Engineering:**
   - Key roles include rail and port maintenance

- Integrates advanced technologies like IoT and data analytics for process optimization.

Calculation and Configuration Topics

1. Rail Network Optimization

- **Calculation:** Load Capacity per Train: $$\text{Total Load
- **Application:** Ensures efficient freight transport
- **Configuration:** Rail Tracking Systems:

- Equip locomotives and wagons with IoT sensors for real-time tracking of performance and freight condition.

2. Port Operations Configuration

- **Calculation:** Container Storage Optimization = f(Yard Space, Container Arrivals, Crane Availability)
  - **Application:** Maximizes container storage efficiency in the yard.
- **Configuration:** Automated Stacking Cranes:

- Integrate robotics and AI for efficient container movement, reducing manual labor and time delays.

3. Pipeline Design

- **Calculation:** Flow Rate in Pipelines: $$Q = A \cdot v$$
  - Where:
    - QQ: Flow rate.
    - AA: Cross-sectional area of the fluid.
    - vv: Velocity of the fluid.
  - **Application:** Ensures optimal transportation of
- **Configuration:** Leak Detection Systems:

- Use sensor networks along pipelines to identify and address leaks instantly, preventing environmental damage.

Experimental Career Development Topics

**1. IoT-Enabled Freight Management**

- **Experiment:** Implement IoT sensors in rail networks and

•□**Focus:** Track cost savings and operational efficiency improvements.

2. Sustainable Port Design

•□**Experiment:** Develop energy-

•□**Focus:** Measure reductions in carbon footprint and energy costs.

3. Career Pathways in Transnet

•□**Experiment:** Assess the impact of Transnet's apprenticeship

•□**Focus:** Compare retention rates and career growth metrics across apprenticeships and traditional hiring pathways.

Innovative Solutions for Transnet Careers

1. Digital Training Modules:
   - Offer simulation-based training for engineers to
2. Data Analytics in Logistics:
   - Use AI-powered analytics to predict freight
3. Leadership Development:

| |
|---|
| o Introduce leadership tracks for employees, focusing on innovation and sustainability in logistics management. |
| |
| background snel career electrical rate |
| |

**SNEL (Société Nationale d'Électricité)**, the national electricity company in the Democratic Republic of Congo, plays a crucial role in power generation, transmission, and distribution. Careers at SNEL offer a variety of opportunities, particularly in the electrical engineering field, as the organization focuses on expanding access to electricity and modernizing its infrastructure.

Background on SNEL

1. Core Activities:
   - Responsible for
   - Operates hydroelectric
2. Electrical Career Opportunities:
   - Engineering Roles:
   - Technician Positions:
   - Sustainable Energy
3. Modernization Goals:
   - SNEL is prioritizing
4. Key Challenges:

- Addressing electricity access disparities, improving grid reliability, and reducing transmission losses.

Rate and Career Development in Electrical Roles

**1. Electricity Tariff Calculations**

- **Formula for Cost of Consumption:** $$\text{Electricity

- **Application:** Teaches professionals how to analyze and optimize consumer energy usage.

2. Load Flow in Electrical Systems

- **Power Flow Calculation:** $$P = VI \cdot \cos(\phi)$$

  - PP: Active power (watts), VV: Voltage, II:

- **Application:** Used to assess system stability and improve efficiency in SNEL's distribution network.

3. Grid Loss Analysis

- Energy Loss in Transmission Lines: $$\text{Power Loss (W)} = I^2 R$$
  - I: Current in amps, kA.
  - Resistance in ohms

- **Application:** Engineers at SNEL can monitor and address line losses to ensure optimal operation.

Experimental Topics for Career Advancement

1. **Renewable Energy Integration**
   - **Experiment:** Study the integration of solar or wind energy into the grid.
   - **Focus:** Analyze impacts on grid stability and reliability.
2. **Energy Efficiency Initiatives**
   - **Experiment:** Develop programs to reduce energy consumption.
   - **Focus:** Test new materials for transmission lines.
3. **Smart Grid Technology**
   - **Experiment:** Implement IoT-based systems to

- **Focus:** Assess the impact of smart meters on consumer energy usage and billing accuracy.

Career Opportunities and Training at SNEL

1. Technical and Vocational Training:
   - Focus on empowering technicians and engineers
2. Leadership Pathways:
   - Opportunities for professionals to grow into
3. International Collaborations:

- Partnerships with global organizations for energy project funding and workforce training.

The **National Institute of Professional Preparation (INPP)** is a vocational and technical training institution that plays a vital role in equipping individuals with practical skills for various industries, including **motoring and automotive services**. Below is an overview and experimental career development ideas in this field:

Background on INPP and Motoring Services

**1. Core Focus Areas:**

- Provides technical training in automotive engineering, electrical systems, and vehicle maintenance.
- Supports workforce development initiatives.

**2. Relevance to the Automotive Industry:**

- Develops skills critical for maintaining modern vehicles.
- Trains professionals in emerging trends such as electric vehicles (EVs) and hybrid technologies.

**3. Integration with Motoring Services:**

- Focuses on practical training for servicing

- Offers certifications in areas like diagnostics, electrical systems, engine repair, and emissions control.

Experimental Career Topics in INPP and Motoring

**1. Vehicle Diagnostics and Maintenance**

- **Experiment:** Compare the diagnostic accuracy of traditional

| | |
|---|---|
| | •□**Focus:** Identify how digital tools improve training outcomes and real-world servicing efficiency. |
| 2. Hybrid and Electric Vehicle Training | •□**Experiment:** Integrate modules on hybrid and EV servicing into |

•□**Focus:** Measure learner adaptability to emerging technologies and job market demands.

3. Fleet Maintenance Optimization

•□**Experiment:** Simulate fleet servicing scenarios to improve

•□**Focus:** Analyze the impact of systematic maintenance practices on fleet downtime and operational costs.

Innovative Approaches for Motoring Careers

1. **Digital Learning Tools:**
   - Utilize augmented reality (AR) and virtual
   - Test trainees' ability to assemble and repair
2. **Sustainable Motoring Practices:**
   - Experiment with teaching sustainable
   - Monitor adoption rates and their effect on
3. **Specialized Certifications:**
   - Develop short-term certification programs for

- Analyze career growth metrics for participants completing these specialized modules.

Calculation Applications for Automotive Training

**1. Engine Performance Evaluation**

- **Formula: Power Output:** $P = T \cdot \omega$
  - P: Power, T: Torque, $\omega$: Angular

- **Application:** Teaches trainees to calculate and optimize engine performance during maintenance.

2. Fuel Efficiency Calculations

- Formula: Fuel Efficiency:
$$\text{Efficiency} =

- **Application:** Evaluates a vehicle's consumption rate and identifies potential efficiency improvements.

3. Brake Performance Assessment

- **Formula: Braking Force:** $$F = m \cdot a$$ $F$: Force, $m$: Mass, $a$: Acceleration

- **Application:** Ensures safe braking functionality during inspections.

Career Opportunities in Motoring

1. **Technical Roles:**
   - Automotive mechanics, electrical technicians, and
2. **Advanced Careers:**
   - Electric vehicle consultants, fleet

3. Entrepreneurial Ventures:

- 

### 1.29.1 Background on Alison

1. **Platform Overview:**
   - Alison offers a vast library of free online
   - Includes certifications in areas such as IT
2. **Career Development Focus:**
   - The platform helps learners in transitioning
   - Courses are tailored for both beginners and
3. **Global Accessibility:**
   - Courses are self-paced, accessible from
   - Target audience includes students

4. Alignment with Career Goals:
   - Alison's offerings align with contemporary career
   - The platform also supports foundational learning for skills required in various industries, making it an important resource for career planning.

Experimental Career Topics

Skill Acquisition and Certification

1. Effectiveness of Free Certifications
   - **Experiment:** Study how completing Alison's free
   - **Focus:** Compare hiring rates of individuals with
2. Skill Retention from Online Courses
   - **Experiment:** Evaluate the retention of skills

- **Focus:** Measure how well learners apply acquired knowledge in real-world scenarios.

Professional Development

3. Career Advancement with Alison

- **Focus:** Analyze career progression metrics.

4. Adaptability to Industry Trends

- **Experiment:** Study how Alison's course offerings

- **Focus:** Track job placements in future-forward sectors.

Learning Effectiveness

5. Impact of Self-Paced Learning
   - **Experiment:** Compare learning outcomes for engagement and
   - **Focus:** Assess learner
6. Global Reach and Accessibility
   - **Experiment:** Analyze how Alison's platform

- **Focus:** Measure the platform's impact on skill development in underserved communities.

Innovative Topics to Explore

1. **Blended Career Pathways:**
   - Combine Alison's online modules with
2. **Language Learning for Global Careers:**
   - Experiment with the role of Alison's language

3. Alison and Emerging Technologies:

- 

1.30.1 e intersection of DHET's NATED and NCV programs, UCPD (Unit for Continuing Professional Development), and electrical engineering provides a solid framework for education, skills development, and innovation. Adding experimental approaches in areas such as assessment methods, engineering applications, and career readiness creates opportunities to enhance outcomes. Here's a structured overview and experimental topic ideas involving the use of "exempters" and marking answer sheets in electrical engineering education:

Background

1. DHET and Technical Education:
   - NATED (National Accredited Technical Certificate Vocational):
     - Focuses on upskilling professionals in technical industry roles.
   - NCV (National Certificate Vocational):
     - Integrates technical engineering
2. UCPD (Unit for Continuing Professional Development):
   - Assessment in NATED and NCV programs,
   - Marking answer sheets,
3. Electrical Engineering
4. Role of Exemptors in Evaluation:
   - "Exempters" (possibly referring to automatic

- They play a crucial role in maintaining accuracy and fairness, while reducing the manual workload for examiners.

Experimental Topics

1. Exam Assessment Methods

1. Automated Marking of Answer Sheets
   - **Experiment:** Test the accuracy and efficiency of
   - **Focus:** Compare results with manual marking to
2. Error Tolerance Levels in Engineering Calculations
   - **Experiment:** Analyze the impact of "exempted"

- **Focus:** Study how error thresholds can be optimized without compromising the integrity of assessments.

2. Training and Professional Development

3. UCPD Programs for Advanced Marking Techniques
   - **Experiment:** Investigate how UCPD training for
   - **Focus:** Measure
4. Skill Transfer through Adaptive Learning Tools
   - **Experiment:** Test the

- **Focus:** Compare knowledge retention between traditional study methods and adaptive software.

3. Engineering Applications in Exams

3. Practical Assessment of Circuit Configurations
   - **Experiment:** Develop a practical assessment for configuring circuits.
   - **Focus:** Assess learner proficiency in setting up and troubleshooting electronic circuits.
6. Material Selection and System Design in Assessment
   - **Experiment:** Include tasks requiring the

- **Focus:** Evaluate the ability of learners to justify their choices based on energy efficiency and safety criteria.

Innovative Topics in Assessment and Engineering

1. Use of IoT for Practical Exams

- **Experiment:** Integrate IoT-

•□**Focus:** Use data analytics tools to evaluate system performance designed by learners.

2. AI in Marking and Grading Systems

•□**Experiment:** Leverage AI-driven marking systems to assess open

•□**Focus:** Measure improvements in subjective and objective assessment accuracy.

3. Standardization of Assessment Tools

•□**Experiment:** Develop standardized templates for

| |
|---|
| •□**Focus:** Ensure consistency in grading practices while accounting for institution-specific variations. |
| |

Integral and derived calculations for a material cone, when intersecting with the goals of DHET's NATED and NCV programs, UCPD initiatives, and electrical engineering, provide an intriguing exploration of education, assessment, and real-world applications. Here’s a deeper dive into how these concepts can blend to enhance outcomes:

Integral and Derived Calculations in Material Cone Applications

1. Volume of a Material Cone (Theoretical Basis)

- **Integral Calculation:** The volume ($V$) of a cone can be

- rr: Base radius of the cone.
- hh: Height of the cone.
- **Derived Formula:** Using the integral: $$V =

- **Application:** Learners in NATED programs can calculate material requirements for projects, such as conical components in electrical insulators.

2. Surface Area of a Material Cone

- **Integral Calculation:** The surface area ($A$) of a cone
  - rr: Radius, $L$: Slant height
  - **Derived Formula:** $$A = \pi r \sqrt{r^2 + h^2}$$

- **Application:** Useful in projects to determine the conductive material needed for electrical systems.

Experimental Topics Using Material Cone Calculations

1. Application in Electrical Insulator Design

- **Experiment:** Calculate the optimal cone size for electrical

•□**Focus:** Analyze trade-offs between material volume and insulation effectiveness.

2. Heat Dissipation in Conical Components

•□**Experiment:** Study how cone-
•□**Calculation:** Heat dissipation
can be evaluated using: $$Q =
kk: thermal
conductivity, AT\ Delta T:

•□**Focus:** Train learners to understand thermal modeling in practical systems.

Integration with UCPD and Assessment Tools

**1. Automated Assessment of Cone Calculations**

•□**Experiment:** Develop a digital tool to mark assessments

| | |
|---|---|
| | •□**Focus:** Compare the accuracy and efficiency of automated grading (using integrals and derived formulas) versus manual marking. |
| 2. Use of IoT Sensors in Practical Cone Applications | |
| | •□**Experiment:** Equip learners with IoT tools to monitor stress or |

•□**Focus:** Evaluate learners’ ability to configure systems based on real-time IoT data.

Career-Focused Innovation

**1. Preparing Learners for Industry-Specific Roles**

| |
|---|
| •Combine material cone calculations with real-world engineering applications in industries like power distribution (City Power, Eskom) or manufacturing. |
| |
| 2. Promoting Advanced Training |
| |

| |
|---|
| •Introduce UCPD modules to deepen knowledge of conical geometries in advanced systems like antennas or transformers. |
| |

Addressing issues like irregularities in transcripts, backlogs in certifications (e.g., SITA-linked NN Diplomas), and alignment with SAQA standards in DHET's NATED and NCV programs requires targeted solutions. Here's a structured overview with experimental topics that can tackle these challenges:

Background

1. DHET (Department of Higher Education and Training)
   - Manages NATED (Nated Accredited technical education in training for Grades
2. Transcripts and Irregularities:
   - Material Transcripts: from private
   - Complaints: Students and institutions often
3. Backlogs and NN Diplomas:
   - Certification delays (e.g., from SITA) are
   - NN Diplomas represent an example where
4. SAQA and Compliance:
   - Ensures qualifications meet national standards

- Delays in the finalization of SAQA certifications affect educational integrity and recognition.

Experimental Topics

1. Addressing Transcript Irregularities

1. Automated Transcript Processing
   - **Focus:** Measure reductions in errors and
   - **Experiment:** Test the impact of digital

2. Complaint Resolution System
   - **Experiment:** Develop a centralized portal for

- **Focus:** Analyze response times and student satisfaction levels.

2. Tackling Backlogs in NN Diplomas

3. Workflow Optimization for SITA Backlogs

- **Experiment:** Pilot streamlined workflows or processing times before
- **Focus:** Compare

4. Provisional Certification Recognition

- **Experiment:** Introduce provisional certifications

- **Focus:** Evaluate the impact of provisional documents on employment and career progression.

3. Enhancing SAQA Compliance

5. Blockchain-Based Certification Verification
   - **Experiment:** Implement blockchain technology to
   - **Focus:** Compare
6. Impact Assessment of Certification Delays
   - **Experiment:** Study the

- **Focus:** Identify industries most affected by backlog challenges and propose priority resolutions.

Innovative Solutions

1. **Standardized Transcript Templates:**
   - Design uniform templates for NATED and
   - Build a national platform for tracking
2. **Digital Qualification Portals:**
3. **Collaborative Task Forces:**

| | |
|---|---|
| | o Create cross-agency teams with DHET, SITA, and SAQA to address systemic inefficiencies and ensure alignment with industry demands. |
| | |

enrich the structured topics presented, let’s explore **calculation-based approaches** tied to the size, configuration, and materials involved in electrical applications for engineering programs. These approaches align with addressing educational and systemic inefficiencies while introducing practical experimental opportunities.

Calculation and Engineering Configuration for Material Efficiency

**1. Material Volume in Electrical System Components**

- **Calculation:** Determine material usage for a cylindrical
  - rr: Radius, hh: Height.

  - **Application:** Helps students calculate material requirements, minimizing waste in NATED or NCV practicals.

2. Electrical Load Sizing for Practical Training

- **Calculation:** Total energy consumption during lab sessions
  - P(t)P(t): Power usage over time

- **Application:** Ensures lab equipment and electrical installations meet training needs without overloading circuits.

3. Optimization of Circuit Designs in Exams

- **Calculation:** Resistance in a wire used for training setups ($R$) is calculated using $R = \rho \frac{L}{A}$, where $\rho$ is resistivity, $L$ is length of wire, $A$: Cross

- **Application:** Teaches learners to optimize circuits for energy efficiency and material use.

Experimental Topics Using Calculations

1. Automated Material Optimization Systems

- **Experiment:** Implement AI tools for predicting material

•□**Focus:** Measure reductions in material waste when integrated into NATED coursework.

2. Dynamic Circuit Configuration in NCV Labs

•□**Experiment:** Develop adjustable circuits for hands-on fault

•□**Focus:** Track learner speed and accuracy in diagnosing faults under exam conditions.

3. Streamlining Transcript Verification

•□**Experiment:** Test blockchain systems for generating and

•□**Focus:** Compare error rates and approval speeds between traditional and digital methods.

Combining Educational and Certification Challenges

**1. Digital Platforms for Certification Delays:**

- ♂ Collaborate with SITA to introduce automated
- ♂ Add progress

**2. IoT-Based Practical Assessments:**

- ♂ Implications for NN

| | |
|---|---|
| | o Use IoT sensors to log student performance during system configurations, ensuring compliance with SAQA's standards. |
| | |

nriching your structured topics with a focus on **maintenance of NN Diplomas**, professional trade development over **5–10 years**, and **calculation-based approaches** can build sustainable career pathways. Below is an integration of these elements into your framework:

Extended Calculation-Based Approaches for Electrical Engineering

**1. Material Durability and Maintenance over Time**

- **Calculation:** Predict wear-and-tear for electrical systems
  - $\Delta M(t)$: Material loss due to usage
  - **Application:** Guides NN Diploma learners in scheduling maintenance or replacement of components like insulators or cables.

2. Energy Efficiency Audits over 5–10 Years

- **Calculation:** Cumulative energy usage in long-term labs
  - $P(t)$: Power consumption at a given

- **Application:** Trains professionals to monitor and optimize energy efficiency, crucial in developing renewable systems.

3. Maintenance Optimization in Circuit Design

- **Calculation:** Resistance drift due to polarization (ΔR(t)/ΔR(t)).

- **Application:** Prepares learners to predict and manage aging circuits in practical systems.

Experimental Career Development Topics

1. Maintenance Strategies for NN Diploma Recipients

- **Experiment:** Introduce structured maintenance training

•□**Focus:** Assess how maintenance expertise improves long-term reliability of electrical installations in professional settings.

2. 5-Year Career Growth Metrics

•□**Experiment:** Analyze trade career progression (e.g., NATED

•□**Focus:** Evaluate salary growth, professional certifications (e.g., UCPD courses), and project success.

3. Digital Platforms for Trade Maintenance

•□**Experiment:** Implement IoT-

•□**Focus:** Track system performance logs, repair schedules, and energy audits.

Solutions for Certification and Systemic Improvements

**1. Backlog Management in NN Diplomas:**
♂ Use predictive models to prioritize hobbies.
**2. SAQA Compliance with Maintenance Records:**
♂ Require periodic updates on system
**3. Professional Trade Upskilling:**

| |
|---|
| ○ Introduce advanced training modules focusing on large-scale infrastructure maintenance (e.g., power grids). |
| |

Adding calculations and considerations for body insurance qualifications, consumer protection phases, and transit award processes provides deeper value to your framework. Here's how these dimensions could further integrate into the provided experimental approaches and enrich the structured topics:

Calculation and Consumer-Focused Approaches

1. Actuarial Calculations for Body Insurance

•**Integral Calculation:** Estimating

- **Application:** Guides learners in understanding the mathematics behind insurance policies for electrical engineering professionals.

2. Consumer Energy Efficiency in Transit Phases

- Cumulative Energy Savings:
  $$\text{Total Savings} = \text{Baseline}_{\text{baseline}} - \text{Energy usage in

- **Application:** Evaluates the benefits of efficient energy systems for consumers and transit infrastructure.

3. Qualification Metrics for Trade and Awards

- **Calculation:** Scoring phase for

- **Application:** Helps standardize and assess trade qualifications and certifications over time.

Experimental Career Development Topics

**1. Awarding NN Diploma Recipients with Maintenance Qualifications**

- **Experiment:** Pilot new award systems for outstanding

•□**Focus:** Assess how recognition motivates consistent skill application in practical scenarios.

2. Insurance as a Support Mechanism in Electrical Engineering Careers

•□**Experiment:** Introduce micro-

•□**Focus:** Measure the uptake and impact on professional resilience during equipment failures.

3. Consumer Protection in Career Development

•□**Experiment:** Develop

- **Focus:** Track knowledge improvements and their impact on resolving administrative challenges.

Innovative Solutions

1. **Digital Platforms for Award Management:**
   - Implement portals to nominate and score
2. **IoT in Insurance Applications:**
   - Leverage IoT devices to
3. **Collaborative Consumer Advocacy:**

| | |
|---|---|
| | o Partner with SAQA and trade organizations to address consumer-level issues in certification processes, ensuring fair treatment in backlogs and complaints. |
| | |

1.30.1 Combining insights into **material irregularities, transcript delays**, and **backlogs** with the dynamics of **City Power, Eskom**, and global industry leaders like **Eaton, Schneider, and Microsoft**, reveals exciting possibilities for resolving systemic inefficiencies and advancing professional career pathways in **NATED DHET programs**. Here's a structured approach to address these topics effectively:

Background and Key Issues

**1. DHET (Department of Higher Education and Training)**

- Focuses on delivering practical and theoretical
- Challenges often include transcript
- Critical players in South Africa's transition with
- Collaboration with industry like Eaton and
- Errors or omissions in
- Backlogs in qualifications

**2. City Power and Eskom:**

**3. Material and Transcript Irregularities**

**4. Trade and Industrial Collaborations**

- Eaton and Schneider specialize in energy

- **Microsoft** brings digital innovations like AI, IoT, and cloud platforms to improve educational and industrial workflows.

Experimental Topics

1. Addressing Transcript and Certification Delays

1. Blockchain Technology for Certification Validation
   - **Experiment:** Implement blockchain to reduce and improve transparency.
   - **Focus:** Reduce delays
2. Digital Portals for Backlog Management
   - **Experiment:** Introduce automated progress

- **Focus:** Measure processing efficiency across DHET institutions.

2. Material and System Configuration

3. Energy Optimization with Eaton and Schneider

- **Experiment:** Develop
- **Focus:** Enhance practical understanding of

4. IoT and AI-Enabled Maintenance with Microsoft

- **Experiment:** Pilot IoT-based platforms for

- **Focus:** Track fault detection and resolution efficiency for NATED learners.

3. Professional Career Development

5. Trade Growth Metrics for Industry Integration

- **Focus:** Evaluate salary growth, certifications, and
- **Experiment:** Develop

6. Collaborative Training Models

- **Focus:** Assess improvements in workforce readiness for modern trade professions.

Innovative Collaborative Opportunities

1. SAQA-Compliant Maintenance Modules:
   - Introduce new SAQA-
2. Blazer-Level Digital Tools from Microsoft:
   - Leverage Microsoft's
3. City Power and Eskom Green Energy Awards:

| | |
|---|---|
| | o Recognize outstanding vocational projects in renewable energy and industrial efficiency, encouraging student innovation. |
| | |

xpanding on these topics with integral and derivative calculations provides mathematical precision for addressing irregularities, optimizing configurations, and advancing collaboration with industry leaders in trade and industrial development. Here's how these calculations can be structured:

Integral and Derived Calculations for Addressing Issues

1. Material Requirements for Energy Systems

- **Volume of Material in Cylindrical Components:**
  - **Application:** Calculates material needs for

- **Optimization:** Students optimize material usage based on real-world requirements in NATED labs.

2. Cumulative Energy Usage in Industrial Systems

- Energy Efficiency Calculation:
  $$\text{Total Energy Used} = \int P(t)\,dt$$ (Power consumption at time $t$)

- **Application:** Trains students to measure and analyze energy usage in City Power or Eskom-supported setups.

3. System Resistance Over Time

- Derivation: Resistance Variation: $\Delta R(t) = R_{initial}$
  - $\Delta R(t)$ (Delta R(t): Incremental resistance

- **Application:** Helps learners in vocational training predict long-term efficiency of electrical systems and identify points of failure.

Experimental Topics Using Calculations

**1. Blockchain Efficiency in Certification Validation**

- **Experiment:** Measure performance improvements using

- **Focus:** Highlights benefits of blockchain for reducing transcript and diploma validation backlogs.

2. IoT and AI-Powered Maintenance in Training

- Energy Savings with Smart Sensors: $\Delta E = \sum_{i=1}^{n} (P_{baseline,i} - P_{smart,i}) \times t_i$
  - $P_{baseline,i}$: Initial power use;

- **Application:** Introduces students to real-time energy monitoring, aligning with Microsoft's digital initiatives.

3. Career Development Metrics Over 5–10 Years

•□Growth Index Calculation:
$$\text{Career Growth} =

- **Focus:** Tracks trade progress among NATED graduates in roles linked to City Power, Eskom, and global partners.

Innovative Collaborative Opportunities

**1. Eaton and Schneider Industry Integration:**

- Develop simulations for student learners on maintenance solutions for

**2. Digital Career Tools via Microsoft:**

- Incorporate Microsoft's

**3. Green Energy Awards with City Power and Eskom:**

| |
|---|
| ○ Use derived metrics like energy savings and material efficiency to select student projects for recognition in renewable energy. |
| |

1.31.1 Atlantic International University (AIU) is known for its flexible and personalized approach to education, offering programs designed for self-paced learning and tailored career development. Here's an overview along with potential experimental career development topics that align with AIU's structure:

Background on Atlantic International University (AIU)

1. **Learning Philosophy:**
   - AIU emphasizes a
   - Programs are designed to be flexible
2. **Academic Offerings:**
   - Offers undergraduate, master's and doctoral
   - Focuses on a combination of
3. **Career-Oriented Education:**
   - AIU's customized curriculums are aligned
   - Students are encouraged to integrate
4. **Global Accessibility:**

- Online platforms make programs accessible worldwide, supporting diverse learners in remote or underserved regions.

Experimental Topics for Career Development

**1. Personalized Learning Impact**

- **Experiment:** Analyze how personalized AI curriculums

| | |
|---|---|
| | •□**Focus:** Compare career advancement (promotions, salary increases) between AIU graduates and traditional university graduates. |
| 2. Self-Paced Learning Outcomes | |
| | •□**Experiment:** Measure skill retention and application in self- |

•□**Focus:** Study how the flexibility of AIU's learning approach affects long-term professional development.

3. Career Alignment with AIU Curriculums

•□**Experiment:** Investigate the

•□**Focus:** Track graduates' success in securing roles directly linked to their personalized curriculum.

4. Cross-Disciplinary Learning Benefits

•□**Experiment:** Explore how AIU's interdisciplinary approach (e.g.

- **Focus:** Study outcomes for graduates entering fields that require multidisciplinary knowledge.

5. Global Career Mobility

- **Experiment:** Examine the role of AIU qualifications in supporting

| | |
|---|---|
| | •□**Focus:** Compare employment rates of AIU graduates in global markets to those with local qualifications only. |
| Innovative Areas for Exploration | |
| **1. Digital Portfolios:**<br>**2. AIU and Emerging Technologies:**<br>**3. Industry-Specific Partnerships:** | ○ Encourage students to create digital portfolios<br>○ Develop curriculums focusing on AI, IoT, or |

- Collaborate with global companies to provide practical case studies and internships linked to AIU coursework.

calculation size configuration electrical material

here are some calculations and considerations related to **size**

1. Calculating Material Volume

- **Formula for Volume of Cylindrical Electrical**
  - Where:
    - : Radius of the cylinder
    - : Height or length of the
  - **Application:** Used to determine the material

2. Sizing Electrical Wires

- **Formula for Resistance of a Wire:** $$R = \rho \frac{L}{A}$$
  - Where:
    - : Resistance in
    - : Resistivity of the
    - : Length of the
    - : Cross-sectional area of the
  - **Application:** Ensures the wire is appropriately

3. Power Capacity in Conductive Materials

- **Power Handling:** $$P = IV$$
  - Where:

- **P**: Power in watts
- **I**: Current in amperes
- **V**: Voltage in volts
- **Application:** Determine the material's

4. Heat Dissipation in Electrical Components

- **Heat Dissipation Calculation:** $$Q = I^2 R t$$
  - **Where:**
    - **Q**: Heat energy in joules
    - **I**: Current in amperes
    - **R**: Resistance in ohms
    - **t**: Time in seconds
  - **Application:** Predicts heat buildup in

5. Configuring Electrical Load for Safety

- **Load Balancing:** $$\text{Total Load} = \int_{t_1}^{t_2} P(t)$$
  - **Where:**
    - **P(t)**: Power drawn by the
  - **Application:** Used to distribute loads in

6. Optimizing Conductive Material for Renewable Systems

- **Efficiency of Renewable Energy Systems:** $$\text{Efficiency} =
  - **Where:**
    - **Output**: Delivered output
    - **Input**: Energy
  - **Application:** Ensures materials and

Experimental Applications

- Simulation of Electrical System
**Behavior:** Use modeling software

•□**IoT Sensors for Real-Time Monitoring:** Apply IoT-enabled tools to track resistance drift and power usage, providing feedback on system health.

Bibliographic Overview: Calculating and Sizing Power Systems

| | |
|---|---|
| **1. Utility Providers and Power System Requirements:** | ▪ Power system calculations in<br>8 Eskom and City Power Johannesburg<br>▪ Application<br>**Example:** Load shedding management uses optimized sizing calculations to balance supply and demand. |
| Educational and Developmental Entities | |

2. DHET and NATED Programs:

- DHET (Department of Higher Education and Training): Focuses on training skilled professionals.
- Load power

3. Sci-Bono Discovery Centre:

- Promotes STEM education through hands-
- Provides platforms for students to explore renewable energy configurations, simulating system load capacities.

Industrial and Technological Contributions

4. Schneider Electric and Eaton Corporation:

- **Schneider:** Known for advanced energy
- **Eaton:** Specializes in smart grids and electrical
- both companies

- Ii. Current, RK:
  - Partners...
- **3. DTIC (Department of Trade, Industry and Competition)**
  - Supports industrial collaboration by aligning partners with councils and institutions to...
- **6. KNETA and Workforce Readiness:**
  - A digital tool that helps students and...
- **7. Microsoft and Digital Innovation:**
  - Provides IoT platforms, machine learning tools...

- Supports the use of advanced analytics to monitor and predict system performance, optimizing configurations in real time.

Experimental Topics Related to Power Calculations

1. Fault Current Management:
   - Experiment with calculations for fault...

- Evaluate real-time fault
  - Study the integration of solar panels into Eskom
  - Assess how NATED program graduates utilize

**2. Renewable Energy Systems:**

**3. Education-Industry Collaboration:**

**4. AI for Load Balancing:**

5.

Implement Microsoft AI solutions for

Career scie bono cost project

- **Education Technology Modules:**
  - Psychometrics applied to learning outcomes and

- Coding processes for system analysis and data management.

Logical Operations:

- Binary System Conversions:
  - Converts binary to decimal to evaluate
  - Example binary codes:
    - A = 011111111111
    - B = 001111111111
    - Sum: A+B+CA + B + C

Control Logic Analysis:

- Feedback and Loop Systems:
  - Loops (e.g., FOR...DO, WHILE) to process

- Task: Evaluate job equivalency using logic-driven data sets.

4. Structured Career Exploration

**Technology and Career Psychometrics:**

- Uses **logical flowcharts** and **modular coding** to evaluate:
  - Learning styles.

- Technical competencies.

System Design and Logical Programming

1. Input-Output Evaluation Steps

1. Input Variables:
   - Collect data from electrical components:
     - **Resistors:**
     - **Capacitors:**
     - **Diodes:** Analyze voltage drops
   - Design modular systems where these
2. Processing Logic:
   - Binary algorithms can evaluate system behavior:
     - Assign binary states to each

▪·Calculate interactions using conditional statements.

2. Key Applications of Mathematical Operations

**Integral Applications:**

- **Energy Calculation:**
  - For capacitors and power systems, compute
    - $P(t)P(t)$: Power as a function of

▪·Application: Analyze total energy consumption or storage over time.

**Derivations:**

- **Rate of Change in Phase Systems:**
  - Derive current or voltage changes in real
    - ▪·Il: Current.
    - ▪·VV: Voltage.

▪·Application: Dynamic analysis in feedback systems to stabilize outputs.

3. Size Configuration in Electrical Systems

**1. Wire Sizing:**

- Optimize wire dimensions to minimize
  - ▪·RR: Resistance.
  - ▪·ρ\rho: Resistivity of the wire
  - ▪·l: Length of the wire
  - ▪·AA: Cross-sectional area
  - ▪·Use for selecting efficient

**2. Component Size Weighting:**

- Assign weighting factors to prioritize
  - ▪·E.g., capacitor size impact on

▪·Balance performance with cost and material availability.

4. Phase Systems and Modular Analysis

1. Modular Phase Configuration:

- Divide systems into logical phases for analysis
  - Phase A-C:
  - Phase D-F:
  - Phase G-I:
    - Elementary
    - Intermediate
    - Advanced

2. Phase Weighting Logic:

- Use binary sequences to model system stability
  - Assign binary configurations

▪·Process data transitions between phases to evaluate outcomes.

5. Algorithm for System Evaluation

**Programming Steps:**

1. Input Variables:

16.11. Research Plan Overview

Provisional Project Topic:

- Implementation Framework
  - Policy:
    - Focuses on engineering
      circular assessments

- Aims to connect entrepreneurship, industry needs, municipality systems, and government initiatives through structured frameworks.

Project Categories:

- Innovation in **energy systems** and **urbanization models** via

•□Science-based approaches to align education and training outcomes with industrial demands.

2. Introduction

•□Defines roles of key stakeholders:
  ○ City Power
  ○ Eskom Entrepreneurs.
  ○ Educational Institutions: Bridge
  ○ Integration challenges between rural and urban

•□**Problem Defined:**

- Need for standardized frameworks to enhance learner competency, intellectual growth, and career transitions.

3. Research Objectives

**Key Questions:**

- How can learner phases (beginner, intermediate, senior) industrial maintenance problems
- What frameworks resolve

- How can timeframes and scheduling mitigate load-shedding impacts on industry and education outcomes?

**Research Aim:**

- Synchronize education systems with industrial needs, ensuring

•□Create innovative models for workplace training, regulatory compliance, and graduate readiness.

4. Engineering Goals

**Design Goals:**

•□Establish entry models for engineering learners based on

| | |
|---|---|
| | •□Develop mandatory frameworks like qualification standards (NQF 1-3) and graduation policies for career integration. |
| | |
| Outcome Goals: | |
| | •□Align city-wide assessments (portfolio-based, formative |

•□Enhance competency ratings and recruitment post-graduation.

5. Methodology

**Materials and Equipment:**

•□**Human Resources:** Educators, trainers, engineers

•□Technical Tools:

- Electrical materials (multimeters, wires, etc.)
- IT systems (robots, USB ports, computational

| |
|---|
| ○ Stationery and electronic records (exercise books, logbooks). |
| |
| Procedure: |
| |
| •□Step-by-Step Tasks: |

- Framework design, policy implementation, and feedback loops.

Career module scaling and learner

**Advanced-Level Diplomas and Certificates**

**5. Advanced Diploma in Basics of Electrical Technology and Circuit**
- Explores circuit
- Estimated time: 15–20 hours

**6. Diploma in Marine Electrical:**
- Specialized course for
- Estimated time: 20–30 hours

**7. Advanced Diploma in Basic Electrical Circuits**
- Discusses circuit
- marine commitment.
- 10–15 hours

**8. Introduction to Electrical Maintenance**
- Intermediate-level
- course on air gap

- Estimated time: 4–5 hours.

Specialized Certificates:

9. Electrical Fundamentals:
   - Covers formulae, key circuit parameters, and
   - Estimated time: 3–5 hours.
10. Essentials of Electrical Safety:
   - Teaches safety rules and electric current effects on human
   - Quick course: 2–3 hours.
11. Fundamentals of Three-Phase Power Transformers:

•□Intermediate-level course on transformer functionality and loss mitigation.

Estimated time: 4–5 hours. jp jacobs

inte jr jacobs internationl research master

Foundation offers specialized programs in

1. **Electrical Design Training**:
    - Covers electrical
    - includes advanced

- Emphasizes compliance with standards like NEC, BS, IEC, and NFPA

Understanding Formulas: Integral and Derivative Functions

- **Derivative Function (f'(x, y)):**
  - Derivatives measure the rate of change of a
  - **Example in Engineering:**
    - The
- **Integral Function ($\int f(x,y)dx$ \int f(x, y) dx):**
  - Integrals represent the accumulation of
  - **Example in Engineering:**

▪·Calculating the total energy in a capacitor ($W=\int V dQ$ W = \int V \, dQ) or the area under the voltage-time graph for evaluating work done.

Courses Integrating Electrical Concepts with Calculus

**1. Configuration and Design:**

- Covers practical
- Calculus is applied in

**2. Calculus and Integral**

**Derivations:**

- Focuses on

- Courses such as *Engineering Calculus Simplified* link integral techniques to solving Maxwell's equations and energy balancing.

Applications of Calculus in Electrical Engineering

- **Circuit Analysis:**
  - Use Kirchoff's voltage and current laws
- **Electromagnetism:**
  - Maxwell's equations heavily rely on partial
- **Signal Processing:**

- Derivatives and integrals are foundational for understanding Fourier transforms and Laplace transforms, tools essential in analyzing electrical signals.

Further Exploration

If you're diving deeper into these

- **Course Recommendations:** AP Calculus BC: Derivatives and

•□**Research Topics:** Investigate the role of integrals in energy storage systems, or derivatives in signal optimization and time-domain analysis.

•□

Next Steps

•□**Short-Term Goals:** Focus on completing current courses like

•□**Long-Term Goals:** Enroll in advanced-level diplomas to deepen technical knowledge, particularly in circuit analysis and electrical safety.

•□

jp jacob master degree engineering

n you're exploring master's degree

options in electrical engineering, the

**1. MEng in Electrical and**

**Electronic (Courses vary):**

- Focuses on Power and
- Includes modules like
- Duration: 1 year full-

- Admission requires an honors degree or equivalent in Electrical and Electronic Engineering

Electrical Engineering CPD Courses

1. University of Cape Town CPD Courses
   - Offers modules like Integrated Energy

- Courses are available online and in-person, tailored for professional development

Key Formulas and Applications:

1. Integral Formulas in Electrical Engineering:
   - Energy Storage in Capacitors: $$W = \int v \, dq$$ Here, $W$ represents the energy stored, $v$ is the voltage, and $q$ is the charge. Integrals are used to calculate the total energy stored over a period.
   - Inductors: $$v = L \frac{di}{dt}$$
2. Derivative Formulas in Signal Processing:
   - Rate of Change in Current: $$i = \frac{dq}{dt}$$ This derivative helps in analyzing how the charge
   - Voltage in Changing Magnetic Fields

▪·Measures the induced electromotive force E\mathcal{E} as the magnetic flux Φ\Phi changes with time.

University of Cape Town CPD Topics and Calculus Applications:

1. Integrated Energy Systems:
   - Use integrals to calculate the total energy
2. Radar Signal Processing:

- Derivatives are central to Fourier Transforms and Laplace Transforms, essential for

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Here’s a structured overview of the topics you’ve mentioned, tailored to different career levels and areas of focus in electrical engineering:

Career Topics in Electrical Engineering

1. Junior-Level Focus:

- 8 Electrical Trade Theory (N1-N2): Covers foundational

▪·Practical applications include single-phase testing, magnetism, and renewable energy basics

Here’s a structured overview of the topics you’ve mentioned, tailored to different career levels and areas of focus in electrical engineering:

Career Topics in Electrical Engineering

1. Junior-Level Focus:

- 8 Electrical Trade Theory (N1-N2):
  - Covers foundational
  - Practical applications
- Advanced Career Topics:
- Mathematical Components in Engineering:
  - Includes calculus, differential equations

- Applications in signal processing, control systems, and electromagnetic field analysis

formule calculus integral derivation
Electrotechnology: Introduces basic electrical principles, circuit analysis, and the use of measuring instruments. Ideal for entry-level roles in electrical installations and maintenance

In **Electrotechnology**, calculus is frequently used to solve real-world engineering problems, particularly in circuit analysis and measuring systems. Here's a breakdown of key calculus-based formulas and their applications:

Integral Formulas in Electrotechnology

**1. Voltage Across a Capacitor:**

$$V(t) = \frac{1}{C} \int i(t) \, dt$$

- **Application:** Integral accumulates the total charge stored

**2. Total Energy Stored in an Inductor:** $$E = \frac{1}{2} \int

- **Application:** Calculates user in analyzing energy transfer

**3. Charge in a Circuit:** $$Q = \int i(t) \, dt$$

- **Application:** Finds the total electric charge QQ flowing through a circuit over time, based on current I(t)I(t).

Derivative Formulas in Electrotechnology

1. **Current in a Capacitor:** $$I(t) = C \frac{dV(t)}{dt}$$
   - **Application:** Relates the rate of change of voltage across a capacitor to the current flowing through it.
2. **Electromotive Force (Faraday's Law):** $$\mathcal{E} = -\frac{d\Phi_B}{dt}$$
   - **Application:** Measures the induced
3. **Voltage-Current Relationship in an Inductor:** $$V(t) = L

- **Application:**
  Determines voltage across an inductor with inductance LL, based on the rate of change of current I(t)I(t).

Practical Applications in Entry-Level Roles

- **Circuit Analysis:**
  - Use integrals and derivatives to analyze RLC
- **Measuring Instruments:**
  - Apply calculus to calibrate and interpret
- **Signal Processing:**

- Fourier and Laplace transforms (advanced calculus topics) help in understanding and filtering electrical signals.

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electrical saqa career undertake material
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The **National Diploma in Electrical Engineering** registered with **SAQA** is an excellent pathway for building a career in electrical engineering. Here's a breakdown of its structure and relevance to your interests in maintenance, soldering, and replacement:

## Overview of the Diploma

- **SAQA Qualification ID:** 111285
- **NQF Level:** 6
- **Credits:** 360
- **Duration:** Typically 18 months, divided into six levels (N1–N6)
- **Purpose:**
  - Provides technical, theoretical, and practical
  - Prepares learners for careers in manufacturing

- Includes workplace learning and in-service training for hands-on experience

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|---|
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| |

| | |
|---|---|
| | into six levels (N1–N6). Purpose: Provides technical, theoretical, and practical knowledge required for electrical engineering roles. Prepares learners for careers in manufacturing, maintenance, and system design. Includes workplace learning and in-service training for hands-on experience |
| | |

The **National Diploma in Electrical Engineering (SAQA Qualification ID: 111285)** is indeed a robust program for individuals aiming to build a career in electrical engineering, particularly in areas like maintenance, soldering, and system replacement. Let's explore its components and applications:

Structure and Curriculum

1. **Levels N1–N6:**
   - The diploma progresses through six levels, each
   - Entry-level modules introduce electrical trade
2. **Key Topics:**
   - **Electrical Trade Theory:** Focuses on basic
   - **Electrotechnology:** Emphasizes circuit
   - **Mathematical Foundations:** Applications
3. **Credits and Duration:**
   - Requires 360 credits and spans 18 months (or

- Includes workplace learning for hands-on experience with tools and techniques.

Practical Applications

- **Maintenance and Replacement:**
  - Training in diagnosing and fixing electrical faults
- **System Configuration:**
  - Learning to design efficient electrical
- **Mathematics in Engineering:**

- Use calculus for analyzing energy storage in capacitors ($W=\int V dQ$ W = \int V \, dQ) and inductors ($E=12L\int i2(t)dt$ E = \frac{1}{2} L \int i^2(t) \, dt).

Career Opportunities

1. **Junior-Level Roles:**
   Maintenance technician
2. **Senior-Level Roles:** Electrical engineer, system designer, or

**3. Advanced Careers:** Research-focused roles in electrotechnical engineering, energy systems, or material innovation.

Next Steps

- **Enrollment:** Seek institutions offering SAQA-accredited

•□**Skill Development:** Focus on modules related to soldering, system replacement, and advanced configurations.

**Future Growth:** Consider supplementing the diploma with CPD-accredited experimental applications:

Background on NCV and NATED Programs

1. **NCV Electrical Infrastructure Construction**:
   - Focuses on skills for domestic, industrial, and
   - Includes modules on electrical principles
   - Covers advanced topics like electrotechnics
   - Prepares students for careers in electrical contracting, maintenance, and repair.

2. **NATED Electrical Engineering**:

Key Topics and Modules

1. Electrical Panels

- **Purpose**:
  - Distribute electrical power safely and
- **Topics**:
  - Panel design and layout.
  - Circuit breakers and fuses.
  - Safety standards and regulations.
- **Experimental Applications**:
  - Assemble and test electrical panels for
  - Simulate fault conditions to evaluate panel safety mechanisms.

2. Wiring

- **Purpose**:
  - Connect electrical components and ensure
- **Topics**:
  - Types of wiring (e.g., single-core, multi-core)

- Wiring diagrams and color codes
- Installation techniques.

- **Experimental Applications**:
  - Practice wiring circuits for lighting and
  - Test continuity and insulation resistance using multimeters.

3. Control Switches

- **Purpose**:
  - Manage electrical circuits and devices
- **Topics**:
  - Types of switches (e.g., toggle, rotary, push
  - Switch ratings and applications
  - Integration with control systems
- **Experimental Applications**:
  - Design control circuits for motors and lighting

- Test switch functionality under varying loads.

4. Fridge and Air Conditioning Systems

- **Purpose**:
  - Maintain temperature control in residential and
- **Topics**:
  - Refrigeration cycles
  - Electrical connections for HVAC systems
  - Troubleshooting and maintenance
- **Experimental Applications**:
  - Wire and test fridge compressors and air

- Measure system efficiency using pressure gauges and thermometers.

Applications Across Fields

1. **Electrical Panels**:
   - Design panels for renewable energy
2. **Wiring**:
   - Implement wiring solutions for smart home
3. **Control Switches**:
   - Develop automated control systems for
4. **Fridge and Air Conditioning**:

- Optimize energy consumption in HVAC systems.

Would you like to explore specific experimental setups, advanced calculations, or tools for any of these topics? Let’s dive deeper into your interests!

The integration of **calculus** in **electrical design and engineering drawing** provides precision and analytical depth in creating efficient systems like **electrical panels**, **wiring**, **control switches**, and **fridge/air conditioning systems**. Here's a deep dive into using calculus and visualization for electrical designs:

1. Electrical Panels and Circuit Design

**Application of Calculus**:

•□**Load Distribution**: Use integrals to calculate the total load on an electrical panel:

$$P_{\text{total}} = \int_0^T P(t) \, dt,$$

where $P(t)$ is the power drawn over time $t$.

**Example**: For a panel supplying $P(t) = 100 + 20t$ W

1. Compute:

$$P_{\text{total}} = \int_0^5 (100 + 20t)\,\left[\frac{1}{2}t^2\right]_0^5$$

2. Result:

Ptotal=(100·5+10·25)−0=750 Wh.P_{\text{

total}} = (100 \cdot 5 + 10 \cdot 25) - 0 =
750 \, \text{Wh}.

**Electrical Drawing**:

- Visualize circuits and panel
connections using orthogonal

- Include components like circuit breakers, busbars, and ground lines.

2. Wiring Layouts and Current Flow

**Application of Calculus**:

•□**Voltage Drop Across Cables**:
Voltage drop is modeled as:

$$\Delta V = \int_0^L I R \, dx,$$

where II: current, RR: resistance per unit length, LL: total length of wire.

**Example**: For $I = 10A, R = 0.5\Omega/m$ and $L = 10 \text{ m}$, $\Delta V = 10 \times 0.5 \times 10 = 50V$.

1. Compute:

2. Result:

$\Delta V = 5 \cdot 20 - 0 = 100 \, \text{V}.$

$= 100 \, \text{V}.$

| |
|---|
| **Electrical Drawing**: |
| •□Produce detailed layouts showing the route and<br><br>•□Use color-coded diagrams for live, neutral, and earth wires. |
| |
| 3. Control Switch Design |
| |
| **Application of Calculus**: |
| |

•□**Switch Response Time**: The behavior of a switch under a varying load is represented by its resistance R(t)R(t):

I(t)=VR(t),where R(t)=R0+kt.I(t) = \frac{V}{R(t)}, \quad \text{where } R(t) = R_0 + kt.

**Example**: For

1. Resistance after 5 s:

2. Current:

$I(5) = \frac{230}{20} = 11.5 \, \text{A}.$

**Electrical Drawing**:

- Design control systems using ladder diagrams.
- Include components like relays, contactors, and timers.

4. Fridge and Air Conditioning Systems

Application of Calculus:

•□**Refrigeration Cycle Efficiency**:
Coefficient of Performance (COP) integrates heat transfer over a cycle:

$$\text{COP} = \frac{\int_0^T Q_{\text{cold}} \, dt}{\int_0^T W \, dt},$$

where QcoldQ_{\text{cold}}: heat removed, WW: work input.

**Example**: For Qcold=300 J/s,W=100 J/sQ_{\text{cold}} =

1. Compute:

COP=∫010300dt∫010100dt=300·10100·10

=3.\text{COP} = \frac{\int_0^{10} 300 \, dt}{\int_0^{10} 100 \, dt} = \frac{300 \cdot 10}{100 \cdot 10} = 3.

Electrical Drawing:

- Create schematics of refrigerant circuits, showing

•□Annotate diagrams with pressure and temperature zones.

Purpose of Calculus in Electrical Design

1. **Optimization**:
   - Minimize energy losses and maximize system
2. **Precision**:
   - Analyze the behavior of electrical components
3. **Design Validation**:

- Ensure system integrity through integrals and derivatives.

By combining advanced calculus techniques with detailed electrical schematics, engineers can create robust systems that are efficient and reliable. Let me know if you'd like further derivations or examples!

Integrating **calculus** into fields like **fitting**, **plumbing**, **masonry**, and **building design** offers a unique analytical framework for precision and efficiency in construction and engineering processes. Here's a comprehensive exploration of these trades with an emphasis on calculations and experimental applications:

## Background on Construction and Engineering Trades

**Fitting, plumbing, masonry, and building design** play pivotal roles in infrastructure

- **Fitting**:
  - Involves assembling mechanical parts and
- **Plumbing**:
  - Focuses on designing and maintaining systems
- **Masonry**:
  - Includes constructing walls, floors, and other
- **Building Design**:

- Encompasses architectural and structural planning to create durable and aesthetic spaces.

Applications of Calculus and Integration

1. Water Flow in Plumbing Systems

•□**Using Integrals**: Calculate water volume flowing through a pipe:

$V = \int_0^T A(t) \cdot v(t) \, dt$,

$v(t) \, dt$,

where A(t)A(t): cross-sectional area of pipe at time tt, v(t)v(t): flow velocity.

**Example**: For $A(t) = 0.05\ \text{m}^2$ and $v(t) = 2 + 0.5t\ \text{m/s}$:

1. Compute:

$$V = \int_0^4 0.05 \cdot (2 + 0.5t)\, dt =$$

$$0.05 \left[2t + 0.25t^2\right]_0^4$$

2. Result:

$V = 0.05(8+4) = 0.6\ \text{m}^3$.

**2. Heat Transfer in Building Design**

| |
|---|
| •□**Using Integrals**: Measure heat transfer across a wall: |
| |

Q=∫0Tk·ΔT·Adt,Q = \int_0^T k \cdot

\Delta T \cdot A \, dt,

where kk: thermal conductivity, ΔT\Delta T: temperature difference, AA: surface area.

**Example**: For k=0.8 W/mKk = 0.8 \, \text{W/mK}, ΔT=15 K\Delta T = 15 \,

1. Compute:

2. Result:

$Q = 120 \cdot 24 = 2880\,\text{Wh}.$

$2880\ \text{Wh}.$

3. Load Distribution in Masonry

•□**Using Integrals**: Analyze load distribution on a wall with a linear weight density w(x)w(x):

L=∫0Ww(x)dx,L = \int_0^W w(x) \, dx,

where w(x)w(x): weight density, WW: width of the wall.

**Example**: For w(x)=50+5xN/mw(x) = 50 + 5x \, \text{N/m} and W=10 mW = 10 \

1. Compute:

\[ L = \int_0^{10} (50 + 5x)\, dx = \left[50x + \frac{5x^2}{2}\right]_0^{10} \]

2. Result:

L=(500+250)−0=750 N.L = (500 + 250) - 0 = 750 \, \text{N}.

Experimental Applications

**1. Plumbing**

- Simulate water flow in pipes of varying diameters to measure

- Create drainage layouts to optimize water removal efficiency.

2. Masonry

- Design wall structures with different material densities to

- Measure thermal insulation of masonry units in buildings.

3. Building Design

- Use 3D modeling software to simulate airflow and temperature

- Experiment with different materials to balance cost, durability, and aesthetics.

Applications Across Trades

1. **Fitting**:
   - Ensure precision in assembling mechanical
2. **Plumbing**:
   - Design efficient water and sewage systems using
3. **Masonry**:
   - Optimize wall thickness and materials for cost
4. **Building Design**:

- Integrate energy-efficient systems to improve sustainability.

The integration of calculus and visualization tools into these trades offers valuable

The **SAQA NATED N Diploma in Electrical Engineering** is a structured program designed to equip students with both theoretical knowledge and practical skills in electrical systems. It prepares learners for careers in electrical design, maintenance, and installation. Here's a detailed breakdown of the topics you mentioned, along with their applications and experimental insights:

1. Log Activity in Electrical Engineering

- **Purpose**:
  - Maintain a detailed record of daily tasks and
- **Components**:
  - Documenting tasks like
  - recording challenges
- **Applications**:
  - Helps track progress

- Provides a reference for future troubleshooting or audits.

2. Undertaking Electrical Material Design

- **Purpose**:
  - Select and design materials for electrical
- **Key Topics**:
  - Properties of conductive materials
  - Insulation materials and their thermal ratings
- **Applications**:
  - Design components like busbars, connectors

- Optimize material usage to reduce costs and improve performance.

3. Inspection of Electrical Systems

- **Purpose**:
  - Ensure that electrical installations comply with
- **Key Topics**:
  - Visual inspection for
  - Testing for continuity, insulation resistance, and
- **Applications**:
  - Conduct inspections for residential, commercial

- Use tools like multimeters, insulation testers, and thermal cameras.

4. Design and Drawing of Electrical Panels

- **Purpose**:
  - Create detailed schematics and layouts
- **Key Topics**:
  - Circuit breaker integration
  - Control systems like PLCs
- **Applications**:
  - Design panels for renewable energy

- Use software like AutoCAD Electrical or EPLAN for precise drawings.

5. Wiring Design and Implementation

- **Purpose**:
  - Develop wiring layouts to connect electrical
- **Key Topics**:
  - Voltage drop calculations and cable
  - Wiring color codes and safety standards
- **Applications**:
  - Implement wiring for lighting, HVAC systems

- Test and troubleshoot wiring systems for faults.

6. Material Design for Components

- **Purpose**:
  - Develop and test components like
- **Key Topics**:
  - Thermal and
  - Design for durability and environmental
- **Applications**:
  - Create prototypes for electrical components

- Test components under varying loads and conditions.

Experimental Applications

1. **Log Activity**:
   - Maintain a daily log of activities.
   - Include sketches, diagrams, and test results.
2. **Material Design**:
   - Test different materials for conductivity and durability.
   - Simulate load conditions to evaluate performance.
3. **Panel Design**:
   - Use software tools to create and simulate panel designs.
   - Assemble and test panels for functionality.
4. **Wiring**:
   - Practice wiring circuits in a controlled

- Measure voltage drops and resistance to ensure compliance.

This program integrates theoretical learning with hands-on experience, preparing students for real-world challenges in electrical engineering. Let me know if you'd like further details or examples on any specific topic!

Incorporating **calculus** into the design and analysis of systems from the **SAQA NATED N Diploma in Electrical Engineering** adds rigor and precision to tasks like panel wiring, material selection, and performance testing. Below, I detail how calculus can enhance each topic:

1. Log Activity: Data Analysis

- **Application of Derivatives**:

- Tracking performance trends from logged data:

dPdt=rate of progress,\frac{dP}{dt} = \text{rate of progress},

where PP: performance level, tt: time.

**Example**: If P(t)=5t2+2tP(t) = 5t^2 + 2t,
the rate of progress at t=3t = 3 hours is:

- **Optimization**:

  - Use integrals to estimate cumulative productivity:

Ptotal=∫0T(5t2+2t)dt.P_{\text{total}} =
\int_0^T \left( 5t^2 + 2t \right) dt.

2. Undertaking Electrical Material Design

- Voltage Drop and Power Loss:

- For a cable with resistance RR and current II, power loss is:

P=∫0LI2R(x)dx,P = \int_0^L I^2 R(x) dx,

where R(x)R(x): resistance at length xx.

**Example**: For $R(x)=0.5+0.01x$R(x) = 0.5 + 0.01x and $I=10\,\text{A}$I = 10 \, \text{A}, find the power loss over $L=10\,\text{m}$L = 10 \, \text{m}:

$$P=\int_0^{10}10^2(0.5+0.01x)dx=100\int_0^{10}(0.5+0.01x)dx.$$P = \int_0^{10} 10^2 (0.5 + 0.01x) dx = 100 \int_0^{10} (0.5 + 0.01x) dx.

P=100[0.5x+0.005x2]010=100(5+0.5)=550
W.P = 100 \left[ 0.5x + 0.005x^2
\right]_0^{10} = 100 (5 + 0.5) = 550 \,
\text{W}.

3. Inspection of Electrical Systems

•□Insulation Resistance Testing:

- Use integral-based models to assess insulation decay over time:

R(t)=R0e−λt,R(t) = R_0 e^{-\lambda t},

where R0R_0: initial resistance,
λ\lambda: decay constant.

**Example**: For R0=100 kΩR_0 = 100 \, \text{k}\Omega, λ=0.02\lambda = 0.02, find R(10)R(10):

R(10)=100e−0.02·10=100e−0.2≈81.87 kΩ.

R(10) = 100 e^{-0.02 \cdot 10} = 100 e^{-0.2} \approx 81.87 \, \text{k}\Omega.

4. Design and Drawing of Electrical Panels

•□**Current Distribution**:

- Use calculus to balance loads across circuits:

Itotal=∫0TI(t)dt,I_{\text{total}} = \int_0^T I(t) dt,

where I(t)I(t): current draw over time.

**Example**: For I(t)=5+t2I(t) = 5 + t^2, the total current over T=4sT = 4 \, \text{s} is:

Itotal=∫04(5+t2)dt=[5t+t33]04=(20+21.33)−0=41.33A.I_{\text{total}} = \int_0^4 (5 + t^2) dt = \left[ 5t + \frac{t^3}{3} \right]_0^4 = (20 + 21.33) - 0 = 41.33 \, \text{A}.

5. Wiring Design

- Voltage Drop Across Wiring:

$$\Delta V = \int_0^L I R \, dx,$$

where II: current, RR: resistance per unit length.

**Example**: For $R=0.2\,\Omega/\text{m}$R = 0.2 \, \Omega/\text{m} and $L=50\,\text{m}$L = 50 \, \text{m}, calculate for $I=10\,\text{A}$I = 10 \, \text{A}:

$$\Delta V = \int_0^{50} 10 \cdot 0.2 \, dx = 10 \cdot 0.2 \cdot 50 = 100 \, \text{V}.$$

$$V = \int_0^{50} 10 \cdot 0.2 \, dx = 10 \cdot 0.2 \cdot 50 = 100 \, \text{V}.$$

6. Material Design for Components

- Heat Dissipation in Components:

- Use Fourier’s law for heat transfer:

$$Q=\int_0^T k A \Delta T \, dt,$$

where kk: thermal conductivity, AA: surface area, ΔT\Delta T: temperature gradient.

**Example**: For $k=0.8\,\text{W/mK}$k = 0.8 \, \text{W/mK}, $A=2\,\text{m}^2$A = 2 \, \text{m}^2, $\Delta T=10\,\text{K}$\Delta T = 10 \, \text{K}, $T=1\,\text{hour}$T = 1 \, \text{hour}:

$$Q = \int_0^1 (0.8 \cdot 2 \cdot 10) dt = 16 \, \text{Wh}.$$

$$(0.8 \cdot 2 \cdot 10) \, dt = 16 \, \text{Wh}.$$

Purpose of Using Calculus in Electrical Engineering

1. **Optimization**: Identify the most efficient design for a system.
2. **Analysis**: Evaluate system behavior under changing

| |
|---|
| **3. Validation**: Ensure designs meet performance and safety standards. |
| |

These principles are directly applied in real-world scenarios, from minimizing power loss to balancing loads and ensuring safety. Would you like more advanced examples or specific applications in any subfield? Let’s refine the exploration further!

**NATED programs** and **ICASS (Internal Continuous Assessment)** framework provide structured guidelines for assessing students across various disciplines, including **engineering**, **natural sciences**, and **business studies**. Below is an exploration of the topics such as marksheet preparation, evaluation tools, and their applications within educational contexts:

Background on NATED and ICASS

1. **NATED Programs**:
   - Offered by the Department of Higher Education and Training.
   - Combine theoretical knowledge and practical assessments.
2. **ICASS (Internal Continuous Assessment)**:
   - Designed to monitor student progress throughout the semester or final mark.

- Requires structured record-keeping and adherence to standardized formats.

Components of Marksheet Guidelines and Assessment

1. **Marksheet Records**:
   - Capture detailed
   - Include theoretical, practical, and project
2. **Tools for Assessment**:
   - **Rubrics**: Ensure
   - **Checklists**: Track task completion and
   - **Grade Scales**:
     - Marks are recorded using
     - **70%-100%**: Excellent
     - **60%-69%**: Good

- 50%-59%: Satisfactory.
- Below 50%: Needs

3. Guidelines for Reporting:
   - Final marksheets must integrate ICASS results.
   - Include:
     - Semester Marks (e.g.,
     - Examination Marks (e.g., external exams = 60% of final mark).

Applications in Key Disciplines

1. Engineering:

- ICASS Structure:
  - Projects assessing practical application of
  - Continuous assessments to evaluate

| | |
|---|---|
| •□**Marksheet Example**:<br>○ Theoretical Tests: 30%<br>○ Practical Assignments: 50%<br>○ Portfolio: 20% | |
| | |
| **2. Natural Sciences**: | |
| •□**ICASS Structure**:<br>○ Lab experiments and fieldwork reports<br>○ Emphasis on scientific method application<br>•□**Tools**:<br>○ Lab evaluation rubrics to assess experimental | |

- Continuous record-keeping for semester performance.

3. Business Studies:

- ICASS Structure:
  - Case studies, presentations, and decision-making and
  - Grading focus on
- Assessment Example:
  - Class Participation: 10%
  - Written Assignments: 40%

- Group Projects: 50%

Final Statement Reports

- Provide a summary of semester achievements.
- Include:
  - ICASS mark breakdown.
  - Exam performance.

- Feedback comments for improvement areas.

Would you like further clarification on specific disciplines, tools, or example calculations for combining ICASS and exam marks? Let’s explore this further!

The application of **calculus and statistics** within the **NATED programs and ICASS framework** can enhance the efficiency and accuracy of evaluating and reporting student performance. Here's an advanced exploration integrating **integrals**, **derivatives**, and **statistical methods** for assessment processes:

Advanced Calculations in Marksheet Preparation

**1. Calculating Semester Marks Using Weighted Averages**

The semester mark combines the theoretical and practical components:

$$M_{\text{sem}} = \frac{w_t T + w_p P}{w_t + w_p},$$

where:

- $T$: Theoretical component score,
- $P$: Practical component score,

•wt,wpw_t, w_p: Weights for theoretical and practical marks.

**Example**: If wt=0.6w_t = 0.6, wp=0.4w_p = 0.4, T=75T = 75, and P=85P = 85:

Msem=(0.6·75)+(0.4·85)0.6+0.4=45+341=

79.M_{\text{sem}} = \frac{(0.6 \cdot 75) + (0.4 \cdot 85)}{0.6 + 0.4} = \frac{45 + 34}{1} = 79.

2. Total Final Mark Calculation

The final mark combines semester marks (SS) and examination marks (EE):

F=0.4S+0.6E.F = 0.4S + 0.6E.

**Example**: If S=79S = 79 and E=82E = 82:

F=0.4·79+0.6·82=31.6+49.2=80.8.F = 0.4

\cdot 79 + 0.6 \cdot 82 = 31.6 + 49.2 =
80.8.

3. Statistics for Grading Trends

•□**Grade Distribution Analysis**: Analyze how grades are distributed across students using measures like mean (μ\mu), variance (σ2\sigma^2), and standard deviation (σ\sigma):

$$\mu = \frac{\sum x_i}{N}, \quad \sigma^2 = \frac{\sum (x_i - \mu)^2}{N}.$$

**Example**: Grades: [75,80,85,70,90][75,

1. Mean:

$$\mu = \frac{75+80+85+70+90}{5} = 80$$

2. Variance:

$$\sigma^2 = \frac{(75-80)^2+(80-80)^2+(85-80)^2+(70-80)^2+(90-80)^2}{5} = 50$$

3. Standard Deviation:

σ=50≈7.07.\sigma = \sqrt{50} \approx 7.07.

4. Integrals for Continuous Assessment Analysis

•□**Cumulative Marks Distribution**: Use integrals to model cumulative performance over time:

Mc=∫0Tf(t) dt,M_c = \int_0^T f(t) \, dt,

where f(t)f(t) represents marks obtained at time tt.

**Example**: If f(t)=10+2tf(t) = 10 + 2t, compute McM_c over [0,5][0, 5]:

\[ M_c = \int_0^5 (10 + 2t) \, dt = \left[10t + t^{2\right]_0}5 = (50 + 25) - 0 = 75. \]

5. Application in Specific Disciplines

**Engineering**:

•□**Project Grades**: Model project grading as a function of effort over time using derivatives:

dPdt=kE(t),\frac{dP}{dt} = kE(t),

where E(t)E(t): effort, kk: a scaling factor.

Natural Sciences:

- **Lab Precision**: Evaluate experiment repeatability using statistical deviation:

CV=σμ×100.CV = \frac{\sigma}{\mu} \times 100.

| Business Studies: |
| --- |
| |
| •□**Case Study Success**: Analyze assignment success using regression models to predict trends: |
| y=mx+b.y = mx + b. |
| Purpose of Calculus and Statistics in ICASS |
| •□Ensure accurate and fair<br>•□Identify trends to improve teaching strategies |

- Generate detailed reports on student performance for ICASS and final evaluations.

Would you like further examples or deeper mathematical insights for your assessment methods? Let’s keep exploring!

The QCTO (Quality Council for Trades and Occupations) oversees the quality

QCTO and NATED Mark Guidelines

1. Purpose:
   - Ensure standardized assessment and
   - Provide clear guidelines for calculating and
2. Components:
   - Internal Continuous Assessment (ICASS)
   - External Summative Assessment (EISA): Final
3. Marksheet Guidelines:
   - Marksheets must integrate ICASS and EISA
   - Weighted percentages are typically applied:
     - ICASS: 40%
     - EISA: 60%

   - Final marks are calculated as:

Khetha Career Development Services

- **Khetha** is an initiative under the Department of Higher Education
- **Marksheet Assistance**:
  - Khetha advisors can guide students on
  - They also assist with career planning based on

Resources for Further Information

- The **QCTO website** provides detailed policies and guidelines for NATED programs. You can explore their resources

he application of **calculus and statistics** in the context of **QCTO and NATED mark guidelines** offers a mathematical approach to ensuring precision and transparency in assessments. Here's a deeper exploration of these topics through advanced formulas, integral-based calculations, and statistical analysis:

1. Calculation of Final Marks Using Weighted Averages

The final mark combines ICASS and EISA scores using a weighted formula:

F=wICASS⋅MICASS+wEISA⋅MEISA,F =

w_{\text{ICASS}} \cdot M_{\text{ICASS}} +
w_{\text{EISA}} \cdot M_{\text{EISA}},

where:

- $W_{\text{ICASS}}, W_{\text{EISA}}$: weights (0.4 and

- $M_{\text{ICASS}}, M_{\text{EISA}}$: scores for ICASS and EISA.

**Example**: If $M_{\text{ICASS}}=75$ = 75 and $M_{\text{EISA}}=80$:

F=0.4·75+0.6·80=30+48=78.F = 0.4 \cdot

75 + 0.6 \cdot 80 = 30 + 48 = 78.

2. Integral Applications in Performance Assessments

•□**Continuous Improvement Tracking**: Assess cumulative improvement in performance across semesters using integrals:

Ptotal=∫0Tf(t)dt,P_{\text{total}} = \int_0^T f(t) \, dt,

where f(t)f(t): improvement rate over time tt.

**Example**: For f(t)=3+2tf(t) = 3 + 2t, compute PtotalP_{\text{total}} over

1. Integrate:

$$P_{\text{total}} = \int_0^{10} (5 + 2t)\,dt = \left[5t + t^2\right]_0^{10}.$$

2. Result:

$$P_{\text{total}} = (50 + 100) - 0 = 150 \ \text{units}.$$

3. Statistical Analysis for Grading Patterns

Use statistical tools to analyze grading trends and ensure equitable assessments.

Grade Distribution

•□Compute the mean (μ\mu) and standard deviation (σ\sigma):

$$\mu = \frac{\sum x_i}{N}, \quad \sigma^2 = \frac{\sum (x_i - \mu)^2}{N}.$$

**Example**: Grades: [70,75,80,85,90][70,
75, 80, 85, 90]. N=5N = 5:

1. Mean:

$$\mu = \frac{70 + 75 + 80 + 85 + 90}{5} = 80.$$

2. Variance:

$$\sigma^2 = \frac{(70-80)^2 + (75-80)^2 + (80-80)^2 + (85-80)^2 + (90-80)^2}{5} = 50 \sigma^2 = \frac{(70$$

3. Standard Deviation:

σ=50≈7.07.\sigma = \sqrt{50} \approx 7.07.

**Grade Scaling**:

Adjust scores to fit desired criteria using linear transformations:

M′=M−MminMmax−Mmin⋅100,M' =

\frac{M - M_{\text{min}}}{M_{\text{max}}
- M_{\text{min}}} \cdot 100,

where M′M': scaled marks,
Mmin,MmaxM_{\text{min}},
M_{\text{max}}: minimum and maximum
raw marks.

4. Reporting and Statement Generation

Use these calculated metrics to prepare
comprehensive student performance
1. Include a breakdown of CA35
and FISA marks

2. Provide feedback on overall trends and improvement areas.

Would you like further examples or visual aids to illustrate these concepts? Let’s exp

| |
|---|
| 1. Weighted Averages in Final Marks |
| |
| Using calculus principles to manage the weighted assessment of **ICASS (40%)** and **EISA (60%)** provides accuracy and fairness: |
| |

F=wICASS⋅MICASS+wEISA⋅MEISA,F =

$$w_{\text{ICASS}} \cdot M_{\text{ICASS}} + w_{\text{EISA}} \cdot M_{\text{EISA}},$$

where wICASS=0.4$w_{\text{ICASS}} = 0.4$ and wEISA=0.6$w_{\text{EISA}} = 0.6$.

**Example**: For a student with MICASS=72M_{\text{ICASS}} = 72 and MEISA=85M_{\text{EISA}} = 85:

F=(0.4·72)+(0.6·85)=28.8+51=79.8.F =

(0.4 \cdot 72) + (0.6 \cdot 85) = 28.8 + 51 = 79.8.

The final mark reflects their holistic performance.

2. Integrals for Performance Tracking

Track progress over time to assess improvement trends:

$$P_{\text{total}} = \int_0^T f(t)\,dt,$$

where $f(t)$: rate of improvement over a semester $t$.

**Example**: Given f(t)=3t2+2tf(t) = 3t^2 + 2t, compute PtotalP_{\text{total}} over T=6T = 6:

Ptotal=∫06(3t2+2t)dt=[t3+t2]06=216+36=252 units.P_{\text{total}} = \int_0^6 (3t^2 + 2t) \, dt = \left[ t^3 + t^2 \right]_0^6 = 216 + 36 = 252 \, \text{units}.

3. Statistical Analysis for Grading Patterns

**Grade Distribution**:

Calculate mean (μ\mu) and standard deviation (σ\sigma) to analyze trends:

μ=∑xiN,σ=∑(xi−μ)2N.\mu = \frac{\sum x_i}{N}, \quad \sigma = \sqrt{\frac{\sum (x_i - \mu)^2}{N}}.

**Example**: Grades: [65,70,75,80,85][65, 70, 75, 80, 85]. N=5N = 5.

1. Mean:

μ=65+70+75+80+855=75.\mu = \frac{65 + 70 + 75 + 80 + 85}{5} = 75.

2. Variance:

$$\sigma^2 = \frac{(65-75)^2+(70-75)^2+(75-75)^2+(80-75)^2+(85-75)^2}{5} = 50$$

3. Standard Deviation:

$\sigma = \sqrt{50} \approx 7.07$.

Advanced Calculations:

1. AM Signal Equation:

m(t)=Ac(1+macosωmt)cosωct,m(t) =

A_c(1 + m_a \cos \omega_m t) \cos \omega_c t,

where ma: modulation index, ACA_c: carrier amplitude, ωc\omega_c: carrier

2. FM Signal Equation:

f(t)=cos(ωct+βsinωmt),f(t) = \cos

(\omega_c t + \beta \sin \omega_m t),

where β\beta: modulation index.

- **Demodulation**:
  - Reverse process to recover original

- Methods include envelope detection (AM) and phase-lock loops (FM).

2. Antenna Systems

- **Operating Principle**:
  - Converts electrical signals into
- Types of Antennas:
  - **Dipole Antenna**:
    Fundamental structure

- **Parabolic Antenna**: Used in satellite TV and high-frequency applications.

3. TV Broadcasting Principles

- **Color Encoding**:
  - TV systems rely on **RGB signals** to reproduce
- **Video Signals**:

- Signals include luminance (brightness) and chrominance (color) for broadcasting.

4. Audio-Video Synchronization

- **Timing**:
  - Audio and video signals must be synchronized to
- **Applications**:

- Live broadcasting systems and multimedia playback.

Practical Experiments

1. Measuring Signal Strength:
   - Use oscilloscopes to analyze the amplitude
2. Building Modulation Circuits:
   - Design AM/FM modulators using
3. Antenna Tuning:

- Adjust antenna lengths to match broadcast frequency for optimal reception.

Applications of Radio and TV Principles

1. **Broadcasting**:
   - Design and optimize systems for radio stations
2. **Signal Processing**:
   - Develop technologies for clear signal
3. **Consumer Electronics**:

- Advance TV displays, radios, and sound systems.

Advance TV displays, radios, and sound systems.

The **NATED syllabus** on **Radio and TV principles** indeed provides essential insights into the world of broadcasting systems. Advanced calculus applications can refine signal analysis, circuit optimization, and system efficiency. Let's explore deeper mathematical concepts and calculations tied to these topics:

Advanced Calculations in Signal Modulation

**1. Amplitude Modulation (AM)**:

The transmitted AM signal is given by:

m(t)=Ac[1+macos(ωmt)]cos(ωct),m(t) =

A_c [1 + m_a \cos(\omega_m t)]
\cos(\omega_c t),

where:

- □ma: Modulation index,
- □ωc=2πfc: Carrier angular frequency

•□ωm=2πfm\omega_m = 2\pi
f_m: Message angular frequency.

**Example Calculation**: For Ac=5 VA_c = 5 \,
\text{V}, Am=2 VA_m = 2 \,\text{V}

1. Modulation Index:

ma=AmAc=25=0.4.m_a = \frac{A_m}{A_c}
= \frac{2}{5} = 0.4

2. AM Signal Equation:

m(t)=5[1+0.4cos(2π·1000t)]cos(2π·10000

0t).m(t) = 5 [1 + 0.4 \cos(2\pi \cdot 1000
t)] \cos(2\pi \cdot 100000 t).

**2. Frequency Modulation (FM)**:

The FM signal is expressed as:

f(t)=Accos[ωct+βsin(ωmt)],f(t) = A_c \cos

\left[\omega_c t + \beta \sin(\omega_m
t)\right],

where:

- □p–Δm\beta = \frac{\Delta
f}{f_m}: Modulation index

•□Δf\Delta f: Frequency deviation.

**Example Calculation**: For Δf=5 kHz\Delta f = 5\ \text{kHz}, fm=1 kHzf_m = 1\

1. Modulation Index:

p=Δfmf=50001000=5.\beta = \frac{\Delta
f}{f_m} = \frac{5000}{1000} = 5

2. FM Signal Equation:

f(t)=10cos[2π·100000t+5sin(2π·1000t)].f(t

) = 10 \cos \left[2\pi \cdot 100000 t + 5
\sin(2\pi \cdot 1000 t)\right].

Advanced Antenna Calculations

**Dipole Antenna Length**:

The ideal length of a dipole antenna for a given frequency is:

$$L = \frac{\lambda}{2} = \frac{c}{2f},$$

where:

- $\lambda$: Wavelength,
- $c = 3 \times 10^8$ m/s: Speed of light,
- $f$: Frequency.

**Example Calculation**: For $f = 100\,\text{MHz}$:

$$L = \frac{3 \times 10^8}{2 \cdot 100 \times 10^6} = 1.5\,\text{m}.$$

TV Broadcasting Principles

**Color Encoding (RGB)**:

The intensity of colors is calculated as:

$$I_{\text{display}} = R \cdot \text{gain}_R + G \cdot \text{gain}_G + B \cdot \text{gain}_B.$$

**Video Signals**:

- Luminance (YY) is:

$$Y = 0.299R + 0.587G + 0.114B$$

- Chrominance (CC) represents color differences.

**Example Calculation**: For R=70R = 70,
G=100G = 100, B=50B = 50:

1. Luminance:

Y=0.299·70+0.587·100+0.114·50=89.93.Y

= 0.299 \cdot 70 + 0.587 \cdot 100 +
0.114 \cdot 50 = 89.93.

Audio-Video Synchronization

•To synchronize audio and video signals:

$$\Delta t = \frac{\Delta L}{c},$$

where ΔL\Delta L: Distance difference,
c=3×108 m/sc = 3 \times 10^8 \,
\text{m/s}.

**Example Calculation**: For ΔL=300 m\Delta
L = 300 \, \text{m}:

Δt=3003×108=1 µs.\Delta t = \frac{300}{3
\times 10^8} = 1 \, \mu\text{s}.

Practical Applications

1. **Broadcast Optimization**:
    - Enhance signal clarity through antenna design
2. **Consumer Electronics**:

- Improve TV quality by fine-tuning RGB color

3. Signal Strength Analysis:

- Conduct experiments using oscilloscopes to measure modulation depth and harmonic distortion.

Let me know if you'd like further expansion on specific topics or more advanced experiments/calculations!

Key Topics in Planning, Supervision, and Organization

1. Planning in Industrial Settings

- **Definition**:
  - The process of setting objectives, identifying
- **Key Elements**:
  - **Forecasting**: Predicting future trends and
  - **Budgeting**: Allocating financial resources
  - **Scheduling**: Creating timelines for project
- **Experimental Applications**:
  - Develop project plans for manufacturing

- Simulate resource allocation for a production line.

2. Supervision in Industrial Environments

- **Definition**:
  - Overseeing and guiding employees to ensure
- **Responsibilities**:
  - Monitoring performance
  - Providing feedback and training
  - Ensuring compliance with safety standards
- **Experimental Applications**:
  - Role-playing scenarios to resolve workplace

- Analyzing case studies on effective supervision techniques.

3. Organization in Industrial Operations

- **Definition**:
  - Structuring teams, workflows, and resources
- **Key Concepts**:
  - **Delegation**: Assigning tasks to the right
  - **Coordination**: Ensuring seamless collaboration
  - **Workflow Design**: Streamlining processes to
- **Experimental Applications**:
  - Create organizational charts for a factory setup

- Design workflows for assembly lines.

Related Experimental Topics

1. **Workplace Safety and Compliance**:
   - Conduct safety audits in a simulated workplace.
   - Develop emergency response plans for [illegible].
2. **Leadership and Team Management**:
   - Simulate team-building exercises.
   - Analyze leadership styles and their impact on [illegible].
3. **Resource Optimization**:
   - Experiment with inventory management techniques.
   - Use software tools to simulate supply chain [illegible].
4. **Quality Control**:
   - Implement quality assurance protocols in a [illegible].

- Analyze defect rates and propose corrective actions.

Applications in Industrial Settings

- **Project Management**:
  - Plan and execute large-scale industrial projects.
- **Operational Efficiency**:
  - Optimize workflows and reduce downtime.
- **Employee Development**:

- Train supervisors to lead teams effectively.

Would you like to explore specific experimental setups or calculations related to these topics? Let’s dive deeper into any area of interest!

area of interest!

Let’s delve into some advanced mathematical calculations and practical implementations within **Planning, Supervision, and Organization** topics in industrial settings. These include forecasting, resource allocation, and optimization strategies for enhanced operational outcomes.

1. Planning in Industrial Settings

**Advanced Calculation: Forecasting Demand**

Forecasting future trends involves techniques like regression analysis or exponential smoothing to predict demand based on historical data.

**Example**: Using exponential smoothing:

$$F_t = \alpha D_{t-1} + (1 - \alpha) F_{t-1},$$

where:

- $F_t$: Forecast for current period,
- $\alpha$: Smoothing constant,
- $D_{t-1}$: Actual demand of the previous period.

•□Ft−1F_{t-1}: Forecast for the previous period.

Given:

•□r0−100F_0 = 100, D1−120D_1 = 120, α=0.2\alpha = 0.2;

1. Calculate F1F_1:

F1=0.3(120)+0.7(100)=36+70=106 units.F_1 = 0.3(120) + 0.7(100) = 36 + 70 = 106 \, \text{units}.

**Advanced Calculation: Budget Optimization**

Budget allocation can be modeled using linear programming to maximize profit or minimize costs:

Maximize: P=c1x1+c2x2,\text{Maximize: }
P = c_1x_1 + c_2x_2,

subject to:

a11x1+a12x2≤b1,x1,x2≥0,a_{11}x_1 +
a_{12}x_2 \leq b_1, \quad x_1, x_2 \geq 0,

where:

- c1,c2c_1, c_2: Contribution per unit.
- aija_{ij}: Resource consumption coefficients.

- b1b_1: Total resources.

**Example**: Maximize P=40x1+50x2P =
40x_1 + 50x_2 subject to:

1. x1+2x2≤60x_1 + 2x_2 \leq 60,

2. 3x1+x2≤903x_1 + x_2 \leq 90.

2. Supervision in Industrial Environments

Efficiency Metrics

Evaluate employee performance using:

Efficiency=OutputStandard Output×100.\text{Efficiency} = \frac{\text{Output}}{\text{Standard Output}} \times 100.

**Example**: An employee produces 80 units in a shift where the standard output is 100 units:

Efficiency=80100×100=80%.\text{Efficiency} = \frac{80}{100} \times 100 = 80\%.

3. Organization in Industrial Operations

**Workflow Optimization Using Queue Theory**

Queue theory assesses workflow bottlenecks. For a single-server queue:

$$L_q = \frac{\lambda^2}{\mu(\mu - \lambda)},$$

where:

- $\lambda$: Arrival rate,

- μ\mu: Service rate.

**Example**: Given λ=5jobs/hour\lambda = 5
__\text{jobs/hour}, μ=8jobs/hour\mu = 8

1. Average jobs in queue:

Lq=528(8−5)=2524≈1.04 jobs.L_q = \frac{5^2}{8(8-5)} = \frac{25}{24} \approx 1.04 \, \text{jobs}.

4. Related Experimental Topics

**Quality Control: Six Sigma**

Calculate process variation using:

Z=X−μσ,Z = \frac{\text{X} - \mu}{\sigma},

where:

- X\text{X}: Observed value,
- μ\mu: Mean,

- □σ\sigma: Standard deviation.

Applications in Industrial Settings

1. **Project Management**:
    - Use Critical Path Method (CPM) to identify
2. **Resource Optimization**:

- Apply inventory models like Economic Order Quantity (EOQ):

EOQ=2DSH,EOQ = \sqrt{\frac{2DS}{H}},

where DD: Demand, SS: Ordering cost,
HH: Holding cost.

Would you like specific implementations, such as CPM schedules or expanded forecasting examples? Let’s explore further!

management production

The fields of **supervision management** and **production management** are crucial aspects of industrial operations, focusing on optimizing resources, improving productivity, and ensuring smooth workflows. Here's an insightful breakdown of these fields and their key topics:

Background: Supervision and Management

**Supervision management** deals with leading and guiding employees to achieve organizational goals while ensuring compliance with safety and operational standards. It acts as the bridge between upper management and the workforce.

**Production management** focuses on planning, organizing, and controlling production processes to maximize efficiency, reduce costs, and deliver high-quality products.

Key Topics in Supervision Management

1. **Roles and Responsibilities of a Supervisor**:
   - Monitoring employee performance
   - Providing training and guidance
   - Resolving workplace conflicts and issues
   - Ensuring adherence to organizational policies
2. **Leadership Styles**:
   - Autocratic: Supervisor makes decisions without employee input.
   - Democratic: Employees are given opportunities to participate in decision-making.
   - Laissez-faire: Employees are given
3. **Workplace Safety**:
   - Conducting risk assessments and

- Training employees to handle equipment safely.

4. **Time and Task Management**:
   - Allocating tasks based on employee strengths.
   - Developing schedules to ensure deadlines are met.

Key Topics in Production Management

1. **Production Planning**:
   - Setting objectives for quantity, quality, and cost.
   - Forecasting demand and resource needs.
2. **Inventory Control**:
   - Managing stock levels to avoid overproduction

- Using models like Economic Order Quantity (EOQ) to optimize inventory:

$$EOQ = \sqrt{\frac{2DS}{H}},$$

where $D$ is demand, $S$ is setup cost, and $H$ is holding cost.

3. **Quality Management**:
   - Implementing quality control techniques
   - Ensuring compliance with industry standards
4. **Workflow Optimization**:

- Using tools like Gantt charts and Critical Path Method (CPM) to map and streamline production processes.

Experimental Applications

1. **Supervision Techniques**:
   - Role-playing scenarios for conflict resolution and performance appraisal.
2. **Production Strategies**:
   - Simulating production lines to identify
   - Experimenting with scheduling methods for
3. **Lean Manufacturing**:
   - Conducting waste analysis using the 5S
   - Applying **Kanban systems** to improve
4. **Safety Drills**:

- Creating emergency response plans and conducting mock drills for employee training.

Applications in Industrial Settings

1. Operational Efficiency:
   - Combining supervision and production strategies
2. Employee Development:
   - Training supervisors to balance productivity and
3. Cost Management:

- Implementing lean manufacturing techniques to reduce operational costs.

Would you like to explore advanced models, experimental setups, or specific tools in these areas? Let’s dive further into these critical topics!

he **NATED syllabus** offers a diverse range of topics, including **personality training**, **financial personality development**, and **educare**, which are essential for personal and professional growth. Here's a detailed breakdown of these areas, their background, and experimental applications:

1. Personality Training

**Background**:

- Focuses on developing interpersonal skills, emotional

- Aims to enhance communication, leadership, and adaptability in various environments.

Key Topics:

1. Self-Awareness:
   - Understanding personality assessments like Myers-
2. Interpersonal Skills:
   - Building effective communication and empathy training
3. Leadership Development:
   - Exploring leadership styles (e.g.

- Training for decision-making and motivational skills.

Experimental Applications:

- Role-playing scenarios to practice conflict resolution

- Group activities to enhance teamwork and collaboration.

2. Financial Personality Development

**Background**:

- Focuses on understanding individual financial behaviors and

- Helps in achieving financial wellness and long-term security.

Key Topics:

1. **Money Personality Types**:
   - Identifying types like
   - Understanding how personality influences
2. **Budgeting and Planning**:
   - Creating effective
   - Tools: budgeting apps and financial planning
3. **Investment Strategies**:
   - Exploring risk tolerance and investment

- Basics of stocks, bonds, and mutual funds.

Experimental Applications:

- Simulating financial planning scenarios

- Analyzing case studies on financial decision-making.

3. Educare

**Background**:

- Focuses on early childhood development, education, and

•□Prepares individuals to work in daycare centers, preschools, and other educational settings.

Key Topics:

1. Child Development:
   - o Understanding physical, cognitive, and psychological
2. Health and Safety:
   - o Ensuring a safe and nurturing environment
   - o Training in first aid and emergency response
3. Daycare Management:
   - o Planning educational activities and managing

- Communication with parents and caregivers.

Experimental Applications:

- Designing lesson plans for early childhood education

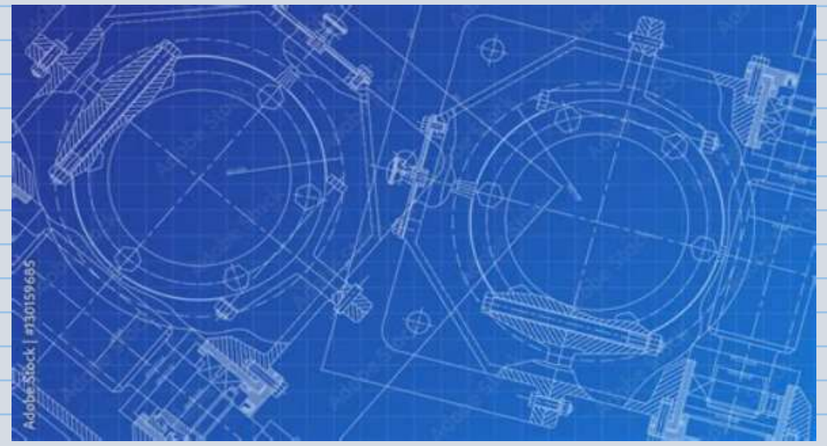
•□Conducting mock daycare setups to practice management skills.

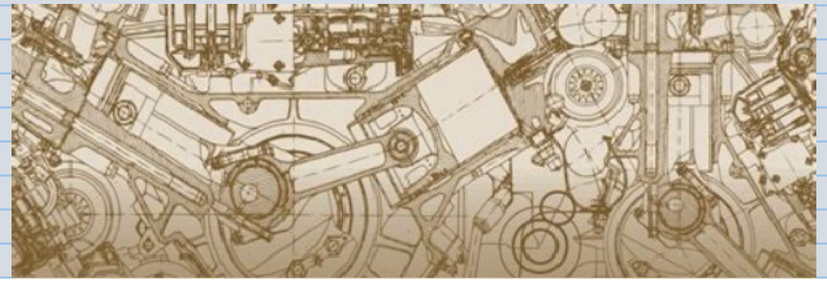
Applications Across Fields

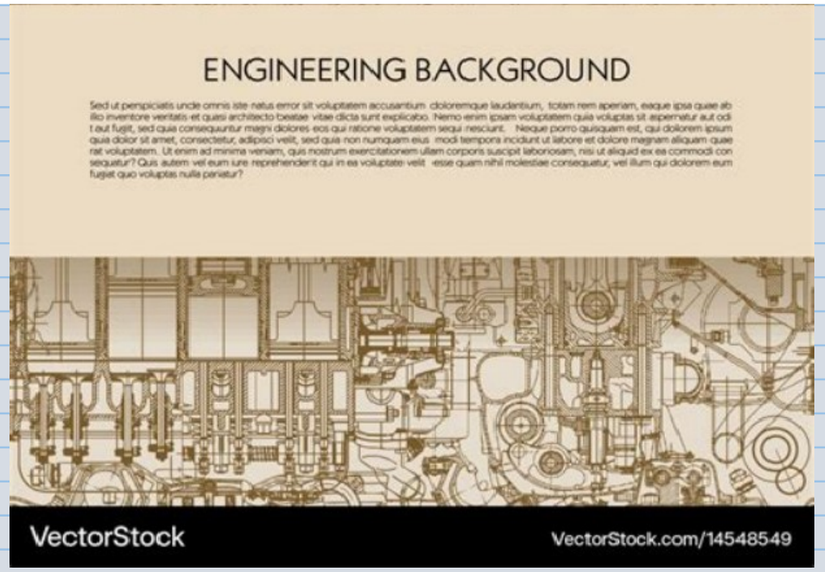
1. **Personality Training**:
   - Enhances workplace dynamics and leadership
   - Builds confidence for public speaking and
2. **Financial Personality Development**:
   - Improves financial literacy and decision
   - Prepares individuals for personal and professional
3. **Educare**:
   - Equips professionals to nurture and educate

- Contributes to the holistic development of children.

Would you like to explore specific experimental setups, tools, or advanced applications in any of these areas? Let’s dive deeper into your interests!

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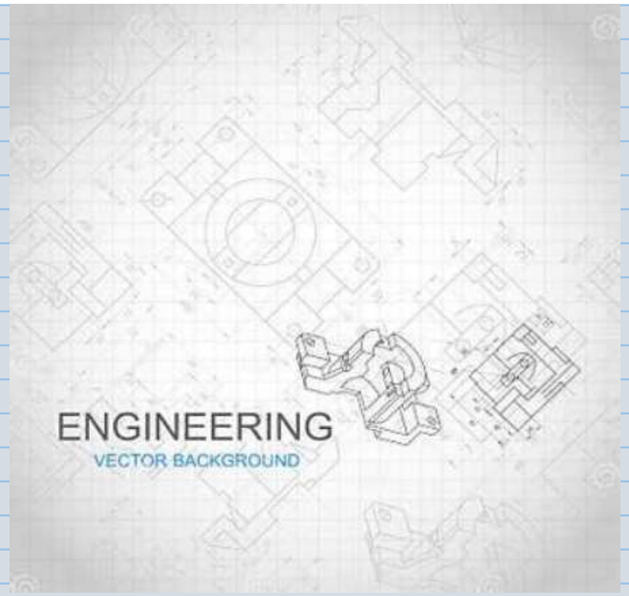
ENGINEERING
VECTOR BACKGROUND

1. Background and Career Topics

- **Level and Credits**:
  - **NQF Level**: 6, **Credits**: 360
- **Pathway**:
  - Prepares learners for careers in specialized
- **Specializations**:
  - High Voltage Installations
  - Renewable Energy Systems
  - Automation (PLCs, Computerized Systems)

- Substation Maintenance and Electrical Circuit Design.

2. Work Experience and Logbook

Learners need evidence of at least 10 completed practical activities in their area

- **Soldering/Desoldering**: For
- **Technical Drawing**: Reading, interpreting, and confirming
- **Wiring and Testing**:
  - Installing circuits (up to 1000 volts AC/1500 volts
  - Testing systems for safe
- **Programmable Logic Controllers (PLCs)**:

- Parameter adjustments and verifying process outputs.

3. Calculations in Electrical Engineering

- **Impedance (RLC Circuits)**:
  - Total impedance: $$ Z = \sqrt{R^2 + (X_L
- **Power**:
  - For AC systems: $$ P = VI\cos\phi \text{ where
- **Energy in Capacitors**:
  - Stored energy: $$ E = \frac{1}{2}CV^2 $$
- **Fault Current**:

- Use Ohm’s Law to compute fault current: $$ I = \frac{V}{Z}, \text{ where Z includes the impedance of the circuit.} $$

4. Employer and Trade Requirements

- Trades are aligned with OFO codes like **571101 (Electrician)** or
- Employers must provide environments for tasks like:
  - Testing electrical wiring.
  - Fault-finding in electrical machines

- Renewable energy system maintenance.

5. Practical Career Applications

- Learners apply skills in:
  - **DB Board Wiring**: Fault-finding and building
  - **High Voltage Systems**: Installing and maintaining

| |
|---|
| ○ **Circuit Design and Fault Finding**: Creating and troubleshooting circuits for automation or renewable systems. |
| |

our outline captures key components of the **National N Diploma in Engineering Studies: Electrical Engineering (SAQA ID: 90674)** and its relevance to career pathways and technical expertise. Let me enhance your understanding by expanding on advanced **integral and derivative calculations** in electrical engineering, while staying aligned with the career and practical contexts.

1. Integral Calculations

**Key Role**: Integrals help analyze energy storage, system behavior over time, and

- **Energy Stored in Capacitors**: $$ E = \frac{1}{2} C V^2 $$ Example: For a capacitor with C=10μFC = 10 \mu F and V=230VV = 230V: $$ E = \frac{1}{2} \times 10 \times 10^{-6} \times 230^2 = 0.2645 \,

•□**Total Energy in a Time Period (AC Systems)**: Calculate energy consumption using: $$ E = \int

P(t) \, dt $$. If P(t)=5sin(2πt)P(t) =

5 \sin(2\pi t), solve: $$ E = \int_0^{1} 5 \sin(2\pi t) \, dt. $$

2. Derivative Calculations

**Key Role**: Derivatives describe system changes, like voltage across inductors.

- **Induced Voltage in Inductors**:
  Voltage across an inductor is: $$

•□**Current Growth in RC Circuits**: Using: $$ i(t) = \frac{V}{R} \left(1 - e^{-\frac{t}{RC}} \right), $$ where VV is voltage, RR resistance, and CC capacitance.

3. Career Applications of Calculations

These concepts find practical applications:

•□**High Voltage Systems**: Analyze
•□**PLC Automation**: Utilize integral

•□**Energy Efficiency**: Apply integrals to calculate power consumption in renewable energy installations.

4. Employer and Trade Context

Employers expect:

•□**Proficiency in Circuit Design**.

•□**Compliance**: Ensure

Fault finding and deriving

installations meet regulatory

| |
|---|
| •□**Advanced Testing**: Measure resistivity, phase conversions, and harmonic distortions. |
| |

The background provided delves into the work experience and skillsets tied to the **National N Diploma: Electrical Engineering (SAQA ID: 90674)**. Here's a detailed breakdown of career applications, competencies, and how these contribute to professional growth in electrical engineering:

1. Career-Relevant Competencies

The listed tasks align with specific electrical trade skills, essential for on-the-

- **Isolation and Safety**:
  - Tasks like isolating fixed wiring circuits
  - Use of lock-out equipment and labeling
- **Fault Diagnosis**:
  - Skills in locating and interpreting fault
  - Testing continuity and insulation resistance
- **Instrumentation and Calibration**:

- Maintaining and calibrating systems (WA1813) ensures accurate readings and reliable equipment operation, critical in energy systems and automation.

2. Career Applications

The skills translate into roles across various sectors:

- **High Voltage Systems**:
  - Specialized tasks in testing resistance
- **Automation and PLCs**:
  - Skills like calibrating equipment and modifying
- **Renewable Energy**:

- Diagnosing and maintaining components in renewable setups like solar panels (WA2110) contributes to sustainable energy solutions.

3. Calculations Supporting These Skills

Advanced calculations play a crucial role in enhancing these tasks:

- **Resistance Testing**:
  - Verifying earth resistance must ensure
- **Insulation Resistance**:
  - This should exceed 1 MΩ, confirming isolation
- **Fault Analysis in Circuits**:

- Use derivatives to study transient behaviors or integrals for analyzing energy losses: $$ i(t) = C \frac{dV}{dt} $$ $$ V(t) = L \frac{di}{dt} $$

4. Practical Growth Path

Completing these work experiences equips learners for:

- **Licensing and Certifications**:
  - Aligning with OPO codes (e.g., 47-1101
- **Advanced Career Roles**:
  - As specialists in instrumentation, control
- **Continued Learning**:

- Pursuing additional training like SCADA or advanced PLC programming to complement skills.

Would you like help with specific calculations or preparation for trade assessments based on these skills? Let me know!

al and derivative calculations as they pertain to the tasks and skills outlined:

1. Integral Calculations

Integrals are critical for analyzing electrical systems, particularly energy, power, and system responses.

**a) Energy in Capacitors**

Formula: $$ E = \frac{1}{2} C V^2 $$

Where:

- CC: Capacitance (Farads),

- VV: Voltage (Volts).

Example: For a 10µF10 \, \mu F capacitor with V=240VV = 240V: $$ E = \frac{1}{2} \times 10 \times 10^{-6} \times 240^2 = 0.288 \, \text{Joules} $$.

**b) Energy in Inductors**

Formula: $$ E = \frac{1}{2} LI^2 $$

Where:

- LL: Inductance (Henries),
- II: Current (Amperes).

Example: For a 2H2H inductor carrying I=5AI = 5A: $$ E = \frac{1}{2} \times 2 \times 5^2 = 25 \, \text{Joules}. $$

c) Cumulative Power Consumption

For time-dependent power P(t)P(t),
energy is: $$ E = \int_{t_1}^{t_2} P(t) \, dt

$$. If P(t)=100sin(2πt)P(t) = 100 \sin(2\pi t), calculate energy over t=0t = 0 to t=1st = 1s: $$ E = \int_0^1 100 \sin(2\pi t) \, dt = \left[-\frac{100}{2\pi} \cos(2\pi t)\right]_0^1 = \frac{100}{2\pi} \times 2 = 31.83 \, \text{J}. $$

2. Derivative Calculations

Derivatives allow for dynamic system analysis, such as rate of change in voltage or current.

**a) Voltage Across Inductor**

Formula: $$ V(t) = L \frac{di(t)}{dt} $$

Where:

- LL: Inductance,

•□di(t)dt\frac{di(t)}{dt}: Rate of current change.

Example: For L=5HL = 5H, i(t)=t2i(t) = t^2:
$$ V(t) = 5 \cdot \frac{d(t^2)}{dt} = 10t.
$$ At \( t = 3s, V = 10 \cdot 3 = 30V. $$

b) Charging of a Capacitor

Current through a charging capacitor: $$ i(t) = C \frac{dV(t)}{dt}. $$ For V(t)=12(1−e−tRC)V(t) = 12(1- e^{-\frac{t}{RC}}), calculate i(t)i(t): $$ i(t) = C \cdot \frac{d}{dt}[12(1 - e^{-\frac{t}{RC}})] = \frac{12C}{RC} e^{-\frac{t}{RC}}. $$

3. Practical Applications

1. **Instrumentation Calibration**:
   - Use integral techniques to calculate cumulative
2. **Fault Diagnosis**:
   - Derivatives help evaluate transient faults
3. **Energy Systems**:

- Integral techniques are essential for measuring total energy generated or consumed in renewable installations.

he **National N Diploma in Engineering Studies: Mechanical Engineering (SAQA ID: 90674)** provides a structured pathway for developing technical expertise and practical skills necessary for careers in mechanical engineering. Let's organize the information for clarity:

1. Background and Competencies

This qualification, at **NQF Level 6 with 360 credits**, equips learners with:

- **Comprehensive Mechanical Engineering Skills**:
  - Design, manufacturing, installation, testing, and maintenance of mechanical equipment.
- **Key Trades**:
  - Diesel Mechanics, Boilermakers, Sheet

- Specializations in Automotive, Aircraft, Heavy Equipment Maintenance, and Fluid Power Systems.

2. Work Experience Tasks

Learners must complete practical activities aligned with core competencies:

- **Machining Operations**:
  - Perform lathe, milling, grinding, and jig boring.
  - Program and operate CNC machines.
- **Mechanical Maintenance**:
  - Diagnose and repair mechanical, pneumatic and hydraulic
  - Install and maintain
- **Advanced Fault-Finding**:
  - Monitor equipment conditions (WA0125) and
- **Assembly and Fitting**:

- Perform precision fitting, alignment, and assembly tasks (WA0120–WA0124).

3. Calculations Supporting Mechanical Engineering

Mathematics plays a crucial role in this field:

- **Torque and Power**:
  - Torque: $$T = F \cdot r \text{ sin}\theta$$
  - Power transmitted in shafts: $$P = \frac{2\pi
- **Fluid Dynamics**:
  - Use integral calculations to analyze
- **Stress Analysis**:

- Stress in materials: $$ \sigma = \frac{F}{A}, \text{ where } F \text{ is force and } A \text{ is cross-sectional area.} $$

4. Career Applications

The skills gained translate into diverse roles:

- Heavy Equipment Maintenance Specialist.
- Fluid Power Specialization: Maintain pneumatic and

•□**Advanced Manufacturing**: Use CNC programming to optimize production efficiency.

Would you like examples of specific calculations for machining, fluid systems, or stress analysis? Let me know how I can assist further!

1. Core Activities and Competencies

The tasks span several vital areas, including diagnostics, system

- **Engine Systems Maintenance**:
  - Maintain cooling
  - Perform
  - Tune diesel engines (WA0141) and rectify
- **Low Voltage Systems**:
  - Diagnose and fix electrical systems
- **Braking and Suspension**:
  - Maintain suspension (WA0151), steering
- **Fuel System Expertise**:
  - Test, overhaul, and service fuel systems (WA0138, WA0139, WA0160).

2. Advanced Diagnostics

These competencies refine fault-finding and repair:

- **Transmissions**:
  - Diagnose and rectify manual and automatic
- **Drive Lines and Final Drives**:
  - Analyze and repair essential mechanical
- **Fluid Conveying Systems**:
  - Manufacture and connect fluid components (WA0159, WA0158).

3. Supporting Evidence Requirements

Competency confirmation involves:

- **Data Interpretation**:
  - Reading and interpreting job sheets
- **Planning and Execution**:
  - Preparing plans for tasks and sequencing
- **Compliance and Safety**:
  - Applying safe work practices (SE0108) and
- **Numerical Operations**:
  - Performing geometry, calculations, and formulae relevant to the scope of work (SE0105).

4. Practical Growth Pathways

The skills acquired translate into specialized roles:

- **Heavy Equipment Maintenance**:
  - Includes diagnostics and system optimization
- **Advanced Systems Tuning**:

- Calibration of control loops in multi-element

- **Component Assembly**:
  - Dismantling, replacing, and assembling engineering components (WA0156).

5. Integral and Derivative Calculations

Mathematical techniques support these activities:

- **Fluid Dynamics**:
  - Analyze flow rates using integrals: $$ Q =
- **Mechanical Stress**:
  - Stress in materials: $$ \sigma = \frac{F}{A} \text{
- **Torque in Systems**:
  - Torque transmitted: $$ T = F \cdot r $$

- Power from torque and RPM: $$ P = \frac{2\pi \cdot T \cdot N}{60}. $$

e **NATED** and **NCV (National Certificate Vocational)** programs offer specialized training in fields like **Applied Policing** and **Crime Resolution**, equipping students with the skills needed to address criminal activities effectively. Here's a detailed breakdown of the background, experimental applications, and key topics related to these fields:

Background: Applied Policing and Crime Resolution

- **Purpose**:
  - To develop

- To prepare students for roles in law enforcement.
- **Applications**:
  - Crime scene management.
  - Evidence collection and analysis.
  - Interviewing witnesses and suspects.

Key Topics in Applied Policing and Crime Resolution

**1. Crime Scene Management**

- **Principles**:
  - Securing the crime scene
  - Documenting the scene through photographs
- **Experimental Applications**:
  - Simulate a crime scene and practice securing and
  - Analyze mock evidence for fingerprints, DNA, or ballistic data.

2. Investigative Techniques

- **Key Concepts**:
  - Conducting preliminary investigations
  - Using surveillance and undercover operations
- **Experimental Applications**:
  - Role-play scenarios for interviewing witnesses

- Practice using surveillance equipment like cameras and GPS trackers.

3. Evidence Handling and Analysis

- Principles:
  - Proper collection, labeling, and storage of evidence to ensure evidence integrity
  - Chain of custody to
- Experimental Applications:
  - Perform forensic analysis on mock

- Use tools like microscopes and chromatography for detailed examinations.

4. Legal Framework

- **Key Topics**:
  - Understanding the Criminal Procedure Act
  - Applying constitutional rights during
- **Experimental Applications**:
  - Mock trials to practice presenting evidence in

- Analyze case studies to identify legal and procedural errors.

5. Crime Prevention Strategies

- **Principles**:
  - Community policing to build trust and rapport.
  - Using data analytics to predict and prevent
- **Experimental Applications**:
  - Develop crime prevention plans for

- Use software tools to analyze crime patterns and hotspots.

Applications in Law Enforcement

1. **Forensic Investigation**:
   - Analyze evidence to reconstruct crime scenes.
2. **Criminal Profiling**:
   - Use psychological and behavioral analysis to
3. **Community Engagement**:

- Build partnerships with local communities to prevent and solve crimes.

Would you like to explore specific experimental setups, tools, or advanced techniques in these areas? Let’s dive deeper into your interests!

The **Applied Policing and Crime Resolution** fields outlined within **NATED and NCV programs** are rich in analytical techniques that intertwine calculus for precise applications. Let's integrate advanced calculations relevant to these topics and explore their experimental implications.

Advanced Calculations in Applied Policing and Crime Resolution

**1. Evidence Decay Over Time Using Exponential Models**

Physical evidence, such as DNA or chemical residues, decays over time, which can be modeled using exponential decay:

$$C(t) = C_0 e^{-\lambda t},$$

where:

- $C(t)$: Concentration of evidence at time $t$,
- $C_0$: Initial concentration,

•□λ\lambda: Decay constant.

**Example**: If the initial concentration of DNA is $C0=100 \text{ng}$, $C_0 = 100 \ \text{ng}$

1. Concentration after 10 days:

C(10)=100e−0.02·10=100e−0.2≈81.87ng.

C(10) = 100 e^{-0.02 \cdot 10} = 100 e^{-0.2} \approx 81.87 \, \text{ng}.

2. Projectile Motion in Ballistic Analysis

When investigating a shooting, the path of a projectile can be modeled by:

y=xtanθ−gx22v2cos2θ,y = x \tan \theta -

\frac{g x^2}{2 v^2 \cos^2 \theta},

where:

- yy: Vertical displacement,
- xx: Horizontal displacement,
- θ\theta: Firing angle,
- vv: Initial velocity,

•□gg: Acceleration due to gravity (9.8m/s29.8 \, \text{m/s}^2).

\text{m/s}, θ=30∘\theta = 30^\circ, and

1. Height (yy):

2. Compute:

$y \approx 57.7 - 0.27 = 57.43\,\text{m}$.y \approx 57.7-0.27 = 57.43 \, \text{m}.

3. Area Estimation for Crime Scene Management

Using calculus, calculate the area of irregular crime scene perimeters. Divide the boundary into segments described by functions, and integrate:

$$A = \int_{x_1}^{x_2} y(x) \, dx.$$

**Example**: For a boundary described by

1. Compute area:

A=∫03(x2+2)dx=[x33+2x]03.A = \int_0^3
(x^2 + 2)\, dx = \left[\frac{x^3}{3} +

2. Result:

A=(273+6)−0=15 m2.A = \left(\frac{27}{3}
+ 6\right) - 0 = 15 \, \text{m}^2.

4. Surveillance Analysis Using Camera Rotation

The angular velocity of a surveillance camera can be modeled as:

θ(t)=ωt+12αt2,\theta(t) = \omega t + \frac{1}{2} \alpha t^2,

where:

- θ(t)\theta(t): Angle rotated,
- ω\omega: Initial angular velocity

•□α\alpha: Angular acceleration.

**Example**: If $\omega = 0.5 \, \text{rad/s}$, $\alpha = 0.1 \, \text{rad/s}^2$, find the angle after $t = 10 \, \text{s}$:

θ(10)=0.5·10+12·0.1·102=5+5=10rad.\the

ta(10) = 0.5 \cdot 10 + \frac{1}{2} \cdot
0.1 \cdot 10^2 = 5 + 5 = 10 \, \text{rad}.

5. Predictive Analytics for Crime Prevention

Using linear regression to predict crime patterns:

$$y = mx + b,$$

where:

- $y$: Predicted crime rate,
- $x$: Variable (e.g., population density),
- $m$: Slope of the trendline,
- $b$: Intercept.

**Example**: If $m = 0.02$ crimes/person, $b = 10$:

1. For $x = 1000$:

$$y = 0.02 \cdot 1000 + 10 = 30 \text{ crimes}.$$

$$1000 + 10 = 30 \, \text{crimes}.$$

Applications in Crime Resolution and Prevention

1. **Forensic Investigations**:
   - Use ballistic and decay models to reconstruct
2. **Crime Scene Management**:
   - Employ area estimation to secure and document
3. **Predictive Policing**:

- Apply regression models and data analytics to forecast and prevent crimes.

Would you like further details on any mathematical model, or should we dive into experimental tools used in these areas? Let’s refine the exploration further!

The **NATED and SAQA NQF programs** provide structured learning pathways for various fields, including **police management information systems**, **incident collision scenarios**, **patrol methods**, **community policing**, **communication skills**, **operational performance**, **traffic management**, **investigation principles**, and **firearm study materials**. Here's a detailed breakdown of these topics and their experimental applications:

1. Management Information Systems in Policing

**Background**:

- Management Information Systems (MIS) in policing are

•□Applications include crime mapping, resource tracking, and performance monitoring.

Experimental Applications:

•□Simulate crime data entry and analysis using MIS tools

•□Develop crime heatmaps to identify hotspots and allocate patrols effectively.

2. Incident Collision Scenarios

**Background**:

•□Focuses on investigating road traffic collisions to determine

- Includes analyzing human, vehicle, and environmental factors.

Experimental Applications:

- Recreate collision scenarios to study impact dynamics

- Use simulation software to analyze vehicle trajectories and collision points.

3. Research Methods for Conducting Patrols

**Background**:

- Patrol methods aim to prevent crime and enhance public safety

- Research involves optimizing patrol routes and schedules.

Experimental Applications:

- Design patrol routes using Geographic Information Systems

•□Conduct randomized patrol experiments to measure crime reduction.

4. Community Policing and Communication Skills

**Background**:

•□Community policing emphasizes collaboration

- Effective communication skills are essential for engaging with diverse populations.

Experimental Applications:

- Role-play scenarios to practice conflict resolution and active

- Develop community engagement plans to address specific safety concerns.

5. Operational Performance in Traffic Management

**Background**:

- Traffic management involves optimizing road safety and flow

- Operational performance measures include response times and accident reduction rates.

Experimental Applications:

- Analyze traffic flow data to identify bottlenecks

•□Implement traffic enforcement strategies and measure their effectiveness.

6. Principles of Police Investigation

**Background**:

•□Investigative principles include evidence preservation, chain of

- Focuses on systematic approaches to solving crimes.

Experimental Applications:

- Conduct mock crime scene investigations to practice

•□Use forensic tools to analyze fingerprints, DNA, and ballistic evidence.

7. Study Material for Police Firearms

**Background**:

•□Covers firearm handling, safety, and competency testing

•□Includes theoretical knowledge and practical training.

Experimental Applications:

•□Practice firearm handling and target shooting in controlled

- Study ballistic properties and their application in investigations.

Applications Across Fields

1. **Crime Prevention**:
   - Use MIS tools to predict and prevent
2. **Traffic Safety**:
   - Develop strategies to reduce road accidents
3. **Community Engagement**:

- Build partnerships with local organizations to enhance public safety.

Would you like to explore specific experimental setups, advanced calculations, or study materials for any of these topics? Let’s refine the learning further!

Delving into **calculus** applications, especially integrals and derivatives, within the fields of **policing and related scenarios**, provides significant tools for solving real-world challenges. Here's how calculus concepts can enhance the understanding of these topics:

1. Management Information Systems (MIS): Optimizing Police Patrol

•□**Crime Hotspot Modeling Using Integrals**: Crime density in a

- Total crime density in a region RR:

D=∫∫Rf(x,y)dxdy.D = \int\int_R f(x, y) \, dx \, dy.

**Example**: If f(x,y)=x2+y2f(x, y) = x^2 + y^2 and RR is a circular region with radius 2 centered at the origin:

1. Use polar coordinates

(x=rcosθ,y=rsinθx = r \cos \theta,

y = r \sin \theta):

D=∫02π∫02(r2)rdrdθ.D = \int_0^{2\pi}
\int_0^2 (r^2)\, r\, dr\, d\theta.

2. Compute:

\[ D = \int_0^{2\pi} \int_0^2 r^3 \, dr \,
d\theta = \int_0^{2\pi}
\left[\frac{r^{4}{4}\right]_0^2 d\theta =
\int_0^{2\pi} 4 d\theta = 8\pi. \]

2. Incident Collision Scenarios

- Projectile Motion and
**Trajectories:** Use derivatives to

- Position as a function of time s(t)s(t):

$$v(t) = \frac{ds}{dt}, \quad a(t) = \frac{dv}{dt}.$$

**Example**: If s(t)=5t2+2ts(t) = 5t^2 + 2t,
calculate velocity and acceleration:

1. Velocity:

v(t)=dsdt=10t+2.v(t) = \frac{ds}{dt} = 10t + 2.

2. Acceleration:

a(t)=dvdt=10 m/s2.a(t) = \frac{dv}{dt} = 10 \, \text{m/s}^2.

3. Patrol Research and Route Optimization

- **Travel Path Optimization Using Integrals**: Minimize distance

- Total patrol distance:

L=∫ab1+(dydx)2 dx.L = \int_a^b \sqrt{1 + \left(\frac{dy}{dx}\right)^2} \, dx.

**Example**: If y=x2y = x^2 and xx ranges from 0 to 1:

1. Compute dydx=2x\frac{dy}{dx}
= 2x, so:

L=∫011+(2x)2dx=∫011+4x2dx.L = \int_0^1

2. Approximate using numerical methods.

4. Traffic Management: Collision Impact

•□**Impulse and Momentum**:
Impulse II is calculated as the integral of force over time:

$$I = \int_{t_1}^{t_2} F(t) \, dt.$$

**Example**: For $F(t) = 10t^2$ from $t = 0$ to $t = 2$:

1. Compute:

$$ I = \int_0^3 10t^2 \, dt = \left[\frac{10t^3}{3}\right]_0^3 = 90 \, \text{Ns}. $$

5. Investigation Principles

- **Decay of Evidence Using Exponential Models**: Biological or chemical evidence decays over time, modeled by:

$$C(t) = C_0 e^{-\lambda t},$$

where $\lambda$ is the decay rate.

**Example**: For $C_0 = 100\ \text{ng}$, $\lambda = 0.05\ \text{day}^{-1}$.

1. Compute:

C(10)=100e−0.05·10=100e−0.5≈60.65 ng.

C(10) = 100 e^{-0.05 \cdot 10} = 100 e^{-0.5} \approx 60.65 \, \text{ng}.

6. Firearm Ballistics

- **Trajectory Calculations**: The path of a bullet can be calculated
  - Horizontal range:

R=v02sin2θg,R = \frac{v_0^2 \sin

2\theta}{g},

where v0v_0: initial velocity, θ\theta:
angle, g=9.8m/s2g = 9.8 \, \text{m/s}^2.

\text{m/s} and θ=45∘\theta = 45^\circ:

1. Range:

R=3002sin90∘9.8=900009.8≈9183.67m.R

= \frac{300^2 \sin 90^\circ}{9.8} =
\frac{90000}{9.8} \approx 9183.67 \,
\text{m}.

7. Community Policing and Predictive Analysis

•□**Crime Trend Analysis Using Regression**: Predict future crimes based on historical data:

y=mx+b,y = mx + b,

where mm is the crime trend rate, and bb is the baseline.

**Example**: Given m=0.05 crimes/day\m = 0.05 \, \text{crimes/day}m=0.05 crimes/day and b=10b = 10b=10;

1. Future crime count after 30 days:

$$y = 0.05 \cdot 30 + 10 = 11.5 \text{ crimes}.$$

$$30 + 10 = 11.5 \, \text{crimes}.$$

These applications highlight the role of calculus in solving real-world policing challenges, from optimizing patrol routes to analyzing forensic evidence. Let me know if you'd like further elaboration or custom examples tailored to your field of interest!

puting, information systems, computer architecture, IT networks, and trading systems, equipping learners with foundational and advanced skills for the digital age. Here's a detailed breakdown of these fields, their purpose, experimental applications, and key topics:

Background and Purpose

1. Technical Computing:
   - Focuses on the design, development, and
   - Applications include programming, system
2. Information Systems:
   - Integrates technology with organizational
   - Applications include database management
3. Computer Architecture:
   - Explores the structure and functionality of
   - Applications include designing efficient
4. IT Networks:
   - Covers the principles of data communication and

- Applications include setting up LANs/WANs

5. **Trading Systems**:
   - Focuses on the use of technology in financial
   - Applications include stock market analysis, risk management, and blockchain integration.

Experimental Applications

1. **Technical Computing**:
   - Develop software programs and languages
   - Simulate hardware configurations to test
2. **Information Systems**:
   - Design and implement database systems
   - Conduct cybersecurity drills to identify
3. **Computer Architecture**:
   - Build and test microprocessor circuits
   - Analyze memory hierarchy and cache
4. **IT Networks**:
   - Set up virtual private networks (VPNs) and test

- Simulate data packet transmission using

5. **Trading Systems**:
   - Develop trading algorithms using machine

- Analyze market trends using data visualization tools.

Key Topics

1. **Technical Computing**:
   - Programming paradigms (object-
2. **Information Systems**:
   - Data modeling and database design
   - Enterprise resource planning (ERP) systems
3. **Computer Architecture**:
   - Instruction set architectures (ISA)
   - Parallel processing and multicore systems
4. **IT Networks**:
   - Network protocols (TCP/IP, HTTP, FTP)
   - Wireless communication and IoT
5. **Trading Systems**:

- Algorithmic trading strategies.

- Blockchain and cryptocurrency technologies.

Applications Across Fields

1. **Technical Computing**:
   - Develop applications for industries like
2. **Information Systems**:
   - Optimize organizational workflows and data
3. **Computer Architecture**:
   - Design hardware for high-performance
4. **IT Networks**:
   - Enhance connectivity and security in enterprise
5. **Trading Systems**:

- Automate trading processes and improve financial decision-making.

Would you like to explore specific experimental setups, advanced calculations, or tools in any of these areas? Let’s dive deeper into your interests!

The **Applied Management N6 syllabus**, as part of the **REPORT 191 Programs**, is designed to provide students with a comprehensive understanding of essential management concepts, with a specific focus on hospitality and service industries. Below is a detailed breakdown of the key modules, their purpose, and experimental applications.

Background and Purpose

The purpose of this subject is to:

- Equip students with critical management skills for roles in

- Train students in analyzing and solving industry-specific challenges, particularly in hospitality management.

This subject provides a blend of theoretical and practical knowledge, preparing students for effective decision-making in competitive business environments.

Key Topics and Insights

1. Introduction to Management Concepts

- **Purpose**:
  - Introduces foundational
- **Experimental Applications**:
  - Case studies on organizational hierarchies

- Role-playing scenarios for managerial decision-making.

2. Labour Relations and Regulatory Challenges

- Purpose:
  - Covers labor laws, dispute resolution, and
- Experimental Applications:
  - Simulate resolving workplace conflicts

- Analyze case studies on labor disputes and regulatory compliance.

3. Job Design and Job Analysis

- **Purpose**:
  - Focuses on defining roles and structuring
- **Experimental Applications**:
  - Create job descriptions and specifications

- Conduct task analysis for different job roles in hospitality.

4. Productivity

- **Purpose**:
  - Develop strategies to improve operational
- **Experimental Applications**:
  - Use tools like Gantt charts and workflow

- Simulate production bottlenecks and test solutions.

5. Performance Management and Appraisal

- **Purpose**:
  - Focuses on evaluating and improving employee
- **Experimental Applications**:
  - Develop performance appraisal templates

- Analyze employee data to provide constructive feedback.

6. Marketing Management in the Hospitality Industry

- Purpose:
  - Introduces marketing strategies tailored to the
- Experimental Applications:
  - Create marketing campaigns for

- Use SWOT analysis to assess competitive positioning.

7. Control Systems and Technology

- **Purpose**:
  - Emphasizes the use of technology and control
- **Experimental Applications**:
  - Implement budgeting control scenarios

- Simulate management of a computerized booking system.

General Guidelines for Evaluation

1. Theoretical Component:
   - Class tests and formal tests contribute to 60% of
2. Practical Assignments:

- Compiled into a portfolio, contributing 40% to the semester mark.

Final Mark:

\text{Final Mark} = \text{Semester Mark (40%)} + \text{Examination Mark (60%)}.

Applications in the Hospitality and Service Industry

- **Human Resource Management**:
  - Train supervisors and managers in evaluating
- **Operational Efficiency**:
  - Streamline processes to reduce costs and
- **Marketing**:
  - Develop data-driven campaigns to attract customers and retain client loyalty.

Would you like me to dive deeper into specific modules or provide advanced practical scenarios for any topic? Let’s expand on this together!

he **Applied Management N6 syllabus** provides a structured framework for understanding advanced management techniques tailored to industries like hospitality. This curriculum equips students with the skills to efficiently manage resources, human capital, and organizational processes. Here's an expanded breakdown of its modules and potential experimental applications.

Key Modules and Focus Areas

**Module 1: Introduction to Management Concepts**

- **Topics**:
  - Human Resources Management:
- **Applications**:
  - Practical tasks involve creating written examples

- Analyze case studies on employee onboarding and integration.

Module 2: Labour Relations and Legislation

- Topics:
  - Employer-employee relations, trade unions
- Applications:
  - Role-playing exercises for grievance handling

- Written assignments focused on dispute resolution in private sectors.

Module 3: Job Design and Analysis

- Topics:
  - Creating job descriptions and
- Applications:
  - Students draft job roles for positions like front

- Practical assignments on analyzing job responsibilities and productivity metrics.

Module 4: Productivity

- Topics:
  - Work study, method study, work
- Applications:
  - Develop work measurement studies to

- Use method study to propose efficiency improvements in task execution.

Module 5: Performance Management and Appraisal

- Topics:
  - Performance criteria, appraisal systems, legal
- Applications:
  - Students conduct role-play evaluations for

- Develop frameworks to address performance-related challenges.

Module 6: Marketing Management in Hospitality

- Topics:
  - The 4P's (Product, Price, Promotion, Place)
- Applications:
  - Create a marketing plan targeting a specific

- Analyze external factors like competition or technology's impact on marketing strategy.

Module 7: Control Systems and Technology

- Topics:
  - Administrative resources, budget
- Applications:
  - Students develop meal plans and inventory

- Simulate software implementation for managing reservations.

Purpose and Experimental Learning

The syllabus blends theoretical foundations with hands-on application

1. Foster critical thinking in real-world scenarios like resolving

2. Equip students with tools to manage challenges in hospitality, from personnel evaluation to stock management.

Would you like detailed calculations or examples for any specific module, such as productivity methods or marketing strategies? Let’s refine the exploration further!

**Integrals and derivatives** provide powerful tools for analyzing and solving problems within the frameworks of the **Applied Management N6 syllabus**. Here's an advanced exploration, integrating calculus concepts and their applications to management scenarios:

## Calculus Applications in Key Modules

### 1. Module 4: Productivity

- Workflow Optimization Using Integrals:

- To maximize efficiency, the total time or cost TT of a process can be modeled as:

$$T = \int_a^b C(x)\, dx,$$

where C(x)C(x): cost or time at a given stage xx.

**Example**: For a kitchen workflow with cost rate $C(x) = 5x^2 + 2x$

1. Compute total cost:

$$T = \int_1^3 (3x^2 + 3x)\, dx =$$

$$\left[ x^3 + \frac{3x^2}{2} \right]_1^3 =$$

2. Result:

T=(5·273+3·92)−(5·13+3·12)=45+13.5−1.6

7=56.83.T = \left(\frac{5 \cdot 27}{3} + \frac{3 \cdot 9}{2}\right) - \left(\frac{5 \cdot 1}{3} + \frac{3 \cdot 1}{2}\right) = 45 + 13.5 - 1.67 = 56.83.

2. Module 5: Performance Management and Appraisal

•□Performance Metrics Using Derivatives:

- Employee performance (PP) can be tracked as a function of time:

dPdt=rate of performance improvement.\frac{dP}{dt} = \text{rate of performance improvement}.

**Example**: If performance follows
P(t) = 2t^2 + 2tP(t) = 2t^2 + 2t, find the rate

1. Compute:

dPdt=6t+2.\frac{dP}{dt} = 6t + 2.

2. At t=5t = 5:

dPdt=6·5+2=32.\frac{dP}{dt} = 6 \cdot 5 +

2 = 32.

3. Module 6: Marketing Management

- Revenue Modeling with Price Elasticity:

  - The total revenue R(p)R(p) based on price pp:

$$R(p) = p \cdot D(p),$$

where $D(p)$: demand function.

**Example**: If $D(p) = 100 - 5p$,
then:

1. Revenue:

$R(p) = p(100 - 5p) = 100p - 5p^2$.$R(p) = p(100 -$
$5p) = 100p - 5pA2$

2. Maximize revenue by finding
dRdp=0\frac{dR}{dp} = 0:

dRdp=100−10p=0 ⟹ p=10.\frac{dR}{dp}

= 100 - 10p = 0 \implies p = 10.

4. Module 7: Control Systems and Technology

- Budget Constraints Using Integrals:
  - To manage inventory and costs:

$$B=\int_0^T c(t)\,dt$$

where c(t)c(t): cost rate over time tt.

**Example**: For c(t)=200−20tc(t) = 200 - 20t over [0,5][0, 5]:

1. Compute:

$$D = \int_0^5 (200 - 20t)\, dt =$$

$$\left[200t - 10t^2\right]_0^5 =$$

2. Result:

B=(200·5−10·52)−0=1000−250=750.B =

(200 \cdot 5 - 10 \cdot 5^2) - 0 = 1000 - 250 = 750.

Purpose of Integrals and Derivatives

- Measure productivity and growth rates.
- Optimize costs and workflows.
- Forecast demand and maximize revenue.

- Model budgetary constraints and evaluate operational performance.

These mathematical insights are pivotal in refining management strategies and enhancing decision-making. Let me know if you'd like further elaboration on specific modules or advanced examples!

Background Experimental and Topics

- **□QCTU NATED**: Refers to the Quality Council for Trades and
- **□rade Theory**: Covers principles of electricity, such as Ohm's Law

•□**Practical Licensing**: Combines hands-on tasks with theoretical knowledge to qualify for licenses in various electrical fields.

Trade Test Topics

**1. Matter and Atoms**: Study of atomic structure, conductivity

**2. Electrical Machines (AC/DC)**:

- Characteristics and
- Testing and maintenance procedures

**3. Test Instruments**:

- Usage of multimeters, oscilloscopes and
- Calibration and measurement techniques

**4. Power Stations**:

- Principles of power generation, including
- Transmission and distribution of electricity

**5. DBs (Distribution Boards) and Relays**:

- Connection, operation, and troubleshooting of

- Use of relays for protection and control.

Testing and Measurement

- **Electrical Circuits**: Application of fault-finding techniques to
- **AC/DC Systems**: Analysis of current, voltage, and power
- **Practical Assessment**:
  - Conducting live tests under supervision to

•□**Trade Reasoning**: Logic and problem-solving applied to real-world electrical challenges.

Your request ties in topics across advanced calculations, licensing theories, trade tests, and applications in electrical engineering. Let me break this down into a meaningful response:

1. Advanced Calculations with Integrals and Derivatives

- Applications:
  1. Impedance Calculations: Use
  2. Voltage and Current Analysis: Employ
  3. Power Systems: Use integrals for energy
  4. Magnetic Flux: Derivatives describe how

5. Harmonics and Resonance: Fourier transforms for harmonics (advanced integration).

2. Experimental Setup and QCTo NATED

- **Framework Purpose**: Combines theoretical (trade theory) and
- **Background Topics**:
  1. **Ohm's Law and Kirchhoff's Rules** for

2. Systematic approaches to **fault-finding and protective devices**.

3. Trade Test Key Areas

- **Matter and Atoms**:
  - Investigates conductivity; explains why
- **Electrical Machines (AC/DC)**:
  - Analyze generator and motor functions; includes
- **Instrumentation**:
  - Proficiency in using and calibrating tools such as
- **Power Stations**:

- Covers the lifecycle of energy generation: from sources (e.g., thermal or hydro) to power transmission and distribution.

4. Testing and Licensing

- **Licensing Theory**: A mix of theory and hands-on practicals in
- **Practical Trade Tests**:
  1. Debugging control
  2. Analysis of DB (distribution boards) and
  3. Relay connection for safety and automation
- **Measurement Proficiency**:

- Utilizing test instruments to measure performance and adherence to safety standards.

our request touches on integrating advanced mathematical concepts like integrals and derivatives with trade theory, psychometric analysis, and real-world electrical engineering topics. Let's organize this response into a clear framework:

1. Advanced Calculations

- Integral Applications:
  - Energy in Inductors and Capacitors: $$E = \int
  - AC/DC Power Analysis:
  - Signal Processing: Use integrals to find the Fourier transforms
- Derivative Applications:
  - Voltage and Current: $$i(t) = C
  - Rate of Change: Derivatives identify

- **Magnetic Flux**:
$$\frac{d\phi}{dt}$$
governs induced EMF in inductive systems.

2. Trade Theory and Licensing

- **Theory**:
  - Electrical laws (Ohm's Law, Kirchhoff's Laws) for electrical installations
  - Safe handling of
- **Practical**:
  - Hands-on assessments focus on installation

- Calibration and use of measuring tools for compliance with licensing standards.

3. Psychometric Testing

- Evaluates logical reasoning and problem-solving abilities.
- Simulates real-world decision-making in trade contexts.

•□Prepares candidates for licensing exams by testing core and practical knowledge.

4. Trade Test Topics

•□Matter and Conductivity:
Differentiating materials
•□AC/DC Machines: Analysis of motor/generator performance
•□Measurement Instruments:
Proficiency with multimeters
•□Power Generation and Transmission:

- Covers energy sources, generation, and efficient delivery through grids.

It seems you are looking to explore advanced calculations, trade test requirements, and licensing in electrical engineering in greater depth. Here's a well-organized recap and extension of your points, tying them to practical and theoretical aspects:

1. Advanced Calculations with Integrals and Derivatives

- Applications:
  - Impedance in RLC Circuits: Use integrals to calculate
  - Voltage and Current Analysis: Derivatives help
  - Power Systems: Integrals estimate total
  - Magnetic Flux Dynamics: Use derivatives

- **Harmonics and Resonance**: Advanced integration (like Fourier analysis) calculates harmonic distortion in power systems, ensuring stability and efficiency.

2. Experimental Setup and QCTo NATED Framework

- **Purpose**:
  - Ensures alignment of theoretical knowledge
  - Focuses on structured fault-finding methods and
- **Topics to Study**:
  - Fundamental laws (Ohm's and Kirchhoff's)

- Protective devices and systematic troubleshooting techniques.

3. Trade Test Key Areas

- **Matter and Atoms**:
  - Understand the atomic structure and how it
  - Differentiate between conductors
- **Electrical Machines (AC/DC)**:
  - Analyze motor and
  - Perform practical tests to evaluate torque
- **Test Instruments**:
  - Mastery of devices like multimeters, oscilloscopes
  - Conduct accurate measurements and
- **Power Stations**:

- Learn about energy generation methods, e.g., steam turbines, photovoltaic systems, and their transmission networks.

4. Practical Licensing and Testing

- **Theory**:
  - Covers wiring regulations
  - Explores safety protocols and
- **Hands-On Assessment**:
  - Test fault-finding skills in practical installations
  - Demonstrate efficient setup and operation of

- Accurate performance of measurements with industry-standard instruments.

This framework should help you systematically prepare for trade tests, licensing exams, and real-world applications. If you'd like help with specific calculations or real-world scenarios, I’m ready to assist!

1. Psychometric and Odometer Testing

- **Psychometric Tests**:
  - Assess problem-
  - Focus on aptitude in
  applying theoretical
- **Odometer Analysis**:

- Can metaphorically represent progress tracking in trade skills and career milestones, ensuring steady growth over time.

2. Power and Energy Applications

- **Power Systems**:
  - Explore energy generation, transmission, and distribution systems, including concepts like peak demand and load
- **Energy Consumption**:
  - Employ integrals to compute energy usage

- Apply power formulas: $$P = VI$$ and $$P = I^2R$$ in practical scenarios.

3. Specifications for Trade Components

- **Component Characteristics**:
  - **Conductors**: High conductivity, high resistance used for safety.
  - **Insulators**: High
  - **Relays and Switches**: Rated based on voltage
- **Daily Maintenance**:
  - Regular inspection of distribution boards

- Calibration of measuring instruments like multimeters and oscilloscopes.

4. Career Guarantee and Long-Term Maintenance

- **Years Guaranteed**:
  - A well-rounded career in electrical engineering
- **Term Maintenance**:
  - Predictive and preventative
- **Characteristic Values**:

- Attributes like resistance, capacitance, and inductance are critical in trade components for system optimization.

Graduate career , institution ,, 1. SAQA Records and NATED Programs

- SAQA (South African Qualifications Authority)
  - SAQA oversees the accreditation of educational programs
  - ICASS (Internal Continuous Assessment
- NATED (National Technical Education Diploma)
  - These programs focus on technical and
    - Reflects marksheets and
  - Your 3 years record.

▪·Includes theoretical and practical components relevant to trades like electrical engineering.

2. Graduate Careers and Institutions

- **Graduate Pathways**:
  - Career options include
  - Further specialization
- **Institutions**:

- Technical colleges or universities offering trade-focused curricula aligned with SAQA and NATED frameworks.

3. Diplomat Calculations

- **Diploma Calculations**:
  - Credits and modules completed during your

- You might be required to achieve specific scores in ICASS assessments and external examinations.

t seems like you're looking for an enriched explanation of the topics outlined, especially focusing on calculations, certificates, and qualification frameworks. Let me break this down for clarity:

1. Background: Calculations (Integrals and Derivatives)

- **Applications in Electrical Trade**:
  - **Energy Analysis**: Use integrals to calculate
  - **Transient Behavior**: Derivatives analyze

- **Practical Example**: A time-dependent current $i(t)=t2i(t) = t^2$ flowing through an inductor of $L=2HL = 2H$: Derive the induced voltage: $$ v(t) = 2 \cdot \frac{d(t^2)}{dt} = 4t $$

2. Certificates and Qualification Statements

- **SAQA and NATED Frameworks**:
  - **SAQA**: Certifies your qualifications to ensure
  - **NATED (National Technical Education**

- **Certificate of Competency**: Achieved upon passing relevant trade tests and meeting SAQA accreditation.

3. Graduate Careers and Institutions

- **Career Pathways**:
  - **Electrical Trade Specialisations**:
    - Advanced roles in electrical engineering, construction, and maintenance.
  - **Institutions Supporting Development**:
    - Institutions aligned with

▪·Some examples include technical colleges offering advanced electrical courses tailored to trade needs.

4. Calculation in Diploma Assessments

- Your diploma credits require meeting specific benchmarks: 8 ICAS3 Assessments. Internal evaluations contributing a significant

- **Calculation Example**: Suppose ICASS contributes 40% to your overall grade and external exams contribute 60%. If your ICASS score is 75% and your external score is 80%: $$ \text{Final Grade} = (0.4 \times 75) + (0.6 \times 80) = 78\% $$

If you'd like deeper insights into any of these concepts or examples, let me know. I can assist with practical calculations, certification requirements, or career planning!

1. Application Overview

- The application includes multiple sections that cater to the

- Submission deadlines and required supporting documents are critical to the approval process.

2. Key Sections in the Application

- **Section A: General Information and Summary**
  - Collects administrative details
  - Includes a list of new or
- **Section B1: New Qualification, Program, or Subject Offering**
  - Requires detailed
  - Supporting documents
- **Section B2: Discontinuing Existing Program**
  - Focus on phase-out
  - Supporting documents
- **Section B3: Higher Certificate Offering**
  - Applies to collaborations with

- Supporting documents include a Memorandum of Understanding (MoU) with the HEI, letters of approval from CHE and DHET, and evidence of student support services.

3. Supporting Evidence for Applications

- **Implementation and Business Plans**:
  - Financial projections, resource allocation, and
- **Health and Safety**:
  - Up-to-date OHS audit reports are mandatory for
- **Council Approval**:
  - Proof of ratification for all changes (new offerings
- **Phase-Out Plans**:

- Strategies to accommodate current students for discontinued programs.

4. Application Process and Compliance

- **Step-by-Step Submission**:
  - Ensure all sections are fully completed and
  - Lodge the application by **30 June** of the
- **Checklist**:
  - Utilize the Annexure A checklist to confirm
- **Director-General Approval**:

- Applications are implemented only upon approval by DHET.

Active Training: Tshingombe fiston

| Title | Type |
| --- | --- |
| EcoXpert Smart Grid, Technical, Intermediate: Geographic Information | Curriculum |
| Basic Machines with PacDrive 3 [VILT] (Test) | Test |

| | |
|---|---|
| Cybersecurity für Schneider Electric Service Partner / Cybersecurity for Schneider Electric Services Partners (German) | Online Class |
| EBO 2023: Engineering EasyLogic | Curriculum |
| Service for Lexium [VILT] (Test) | Test |
| 20 Mobile Terms You Probably Know | Curriculum |
| Schneider Home Certification | Curriculum |
| EBO 2022: Engineering EBO | Curriculum |
| EBO 2023: Engineering EBO | Curriculum |

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|---|---|
| EBO 2024: Engineering EBO | Curriculum |
| EBO 2022: Value Based Selling | Curriculum |
| DIN Ethernet Technical Overview | Online Class |
| Applying OWASP 2017 Mitigations Series | Curriculum |
| EcoStruxure Power Foundational 2.0 | Online Class |
| Fundamentals of Threat Modeling | Online Class |
| Sustainability School for Partners Chapter 2 | Curriculum |
| Basic Machines with PacDrive 3 (Test) | Test |

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|---|---|
| EcoStruxure Building Technical Training<br>For EcoXperts 2023 - Proficient | Curriculum |
| Introduction to EcoCare : Next<br>Generation Services Membership | Online Class |
| Escola de Sustentabilidade para<br>Parceiros- Capítulo 1 (Sustainability School | Curriculum |
| Motion Block : Part I (Test) | Test |
| Transformers and motor applications in<br>industries | Curriculum |
| EBO 2023: Engineering Upgrade | Curriculum |
| PowerLogic P5: Protection Engineering | Curriculum |
| EVlink ProAC Calibration Law Compliant<br>Basic (German) | Online Class |

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|---|---|---|
| | EcoStruxure Building: Graphics Editor Intermediate | Online Class |
| | Electrical Arc Flash Awareness | Online Class |
| | EcoStruxure Panel Server: Architectures around Panel Server | Online Class |
| | Sustainability School for Partners Chapter 1 | Curriculum |
| | Understanding the cash flow statement | Online Class |
| | Personal Protective Equipment Overview | Online Class |

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| | Building Controls II: Control Sensors | Online Class |
| | EcoStruxure Building: Prescription - Mechanical & Control - Part 1 - HVAC Basics | Curriculum |
| | Masterpact M auf Masterpact MTZ - Modernisierung mit ECOFITTM/ Masterpact M to Masterpact MTZ upgrade solutions with ECOFITTM (German) | Online Class |
| | Be S.A.F.E. First | Online Class |
| | EVlink ProAC Calibration Law Compliant Basic (German) | Online Class |
| | KNX Basic Certification Blended | Curriculum |

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|---|---|---|
| | Introduction à EcoStruxure Grid: Foundational/Introduction to EcoStruxure Grid: Foundational (French) | Online Class |
| | PowerLogic: Technical Overview | Curriculum |
| | Testes Altivar Technique | Curriculum |
| | Advanced Power Metering: PowerLogic ION9000 Technical Overview: Part 1 | Online Class |
| | Robotics (Test) | Test |
| | Social Selling (Season 1) - SEIQ | Material |
| | Understanding Software Licensing | Online Class |
| | Drives: Fundamentals of Kinematics: Part 2 of 2 | Video |

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|---|---|---|
| | LayoutFAST: General Overview | Online Class |
| | Motion Block Basics | Online Class |
| | Material Working Machinery: Discover the Machines | Online Class |
| | Drives: Fundamentals of Kinematics: Calculation Downhill Conveyor | Video |
| | Field Services Operations : BCEC BCWC TurboCor for FSR Test | Test |
| | Motor Starters with Contactors | Curriculum |

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|---|---|---|
| | Discover the Hotels Market | Online Class |
| | Correntes de curto-circuito/Short-Circuit Currents (Portuguese) | Online Class |
| | EcoStruxure Building: Graphics Editor Advanced | Online Class |
| | EBO 2023: EIA 485 Electrical and Physical Characteristics | Online Class |
| | Active Harmonic Filter: HMI Screens (PowerLogic™ AccuSine PCSP & PCSn) | Video |
| | Altivar Drives: Braking Function (Test) | Test |

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| | Escolha da área da seção transversal do cabo/Choice of Cable Cross-Section Area (Portuguese) | Online Class |
| | EcoStruxure Plant: Safety | Video |
| | Module 1: Battery Basics | Online Class |
| | Foundations of Data Center Physical Infrastructure Management | Online Class |
| | Test: Physical Infrastructure Management Basics Quiz | Test |
| | Easy Lexium 16 Servo Drives & BCH Servo Motors (English) / Servoaccionamientos Easy Lexium 16 y servomotores BCH (Spanish) | Online Class |

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|---|---|---|
| | Physical Infrastructure in IT Network | Curriculum |
| | An Introduction to Life Sciences (Test) | Test |
| | An Introduction to Life Sciences | Video |
| | The Convergence of IT/OT: 2- The Impact of the Digital Transformation | Online Class |
| | Altivar Machine Professional | Curriculum |
| | Compreendendo a compatibilidade eletromagnética/Understanding Electromagnetic Compatibility (Portuguese) | Online Class |

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| | Drives Basics: Electromagnetic Compatibility (EMC) | Online Class |
| | ELECTRICAL SAFETY IN THE WORKPLACE For non-electrical staff | Online Class |
| | Electronic VAR Compensation : Technical Overview – HMI Screens PowerLogic™ AccuSine PVC+) | Video |
| | Notions de base sur l'électricité : électrons en mouvement / Electricity Basics: Moving Electrons (French) | Online Class |
| | Energy Server Com'X 510: Technical Overview | Online Class |
| | Drives: Fundamentals of Kinematics : Part 1 of 2 | Video |

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|---|---|---|
| | Industrial Edge for the WWW Industry Part 1 | Video |
| | Industrial Management | Online Class |
| | Power Quality and Power Advisor Summary | Video |
| | Regulations & Regulatory Guidance in Life Sciences (Test) | Test |
| | Retrofit Power Metering: PowerLogic BCPM Technical Overview | Online Class |
| | Power Meters: Meters Positioning Initiative #1 | Video |
| | Power and Energy Meters | Video |
| | New Easy UPS On-Line Lithium-ion 1-3kVA & NMC, established Easy UPS, Easy Parts & PDU | Video |
| | Surveillance et alerte de la distribution électrique /EcoStruxure Power: Electrical Distribution Monitoring & Alarming | Online Class |

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|---|---|---|
| | Introdução ao projeto de distribuição de baixa tensão/Introduction to Low Voltage Distribution Design (Portuguese) | Online Class |
| | Discover Motor Control: Part 2: Branch Circuit I | Online Class |
| | Innovation Talk: Basics of RFID Sensors for Controlling Access | Video |
| | IDPE Section 4: Molded Case Circuit Breakers (Test) | Test |
| | Test ProDiag Breaker for Field Services Representative (FSR) | Test |
| | Design Canalis with CanCAD : Project execution checklist Part 3 | Online Class |

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| | Design Canalis with CanCAD : Conclusion Part 7 | Online Class |
| | Altivar Soft Starter: ATS22 Mounting and Cabling | Video |
| | Altivar Machine: ATV340: Mounting and Cabling: Part 3 of 4 | Video |
| | Altivar ATV12 Mounting and Cabling: Part 1 | Video |
| | Design Canalis with CanCAD : Launch CanCAD and introduction Part 2 | Online Class |

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| Altivar Process: Mounting and Cabling: Floorstanding: Part 2 of 2 | Video |
| Altivar Machine: ATV340: Mounting and Cabling: Part 4 of 4 | Video |
| EcoStruxure Security Expert: ESMI Transition Post Transition, Part 4 of 4 | Video |
| Introduction to Transformer Protection Basics | Online Class |
| Masterpact MTZ for Services Representative (SR) | Test |
| EcoStruxure Security Expert: An introduction to EcoStruxure Security | Video |
| EcoStruxure Security Expert: INET to Security Expert Transition (Test) | Test |

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| EcoStruxure Security Expert: ESMI – Security Expert -transitio: Tietokannan muunnos Esmikosta Security Experttiin, Osa 3/4 | Video |
| Discover High Impedance Busbar Protection | Online Class |
| Discover Advanced Distance Protection | Online Class |
| Introduction to Distance Protection | Online Class |

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| | Discover Low Impedance Busbar Protection | Online Class |
| | Discover Basic Line Differential Protection | Online Class |
| | Discover the basic arc protection principles and offers | Online Class |
| | Discover Advanced Command and Control Features | Online Class |
| | Discover Basic Command and Control Features | Online Class |

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| EcoXpert Substation Automation, Proficient, Decentralized Architecture | Curriculum |
| Motor Protection: Part 3: Coordination in Motor Starters | Online Class |
| Motor Protection: Part 2: Motor Protection | Online Class |
| Discover Basic Generator Protection | Online Class |
| Discover Advanced Generator Protection | Online Class |

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|---|---|---|
| | Deliver Switchboard Project Digitally: Episode 1 | Video |
| | EcoXpert Smart Grid, Technical, Intermediate: Grid Operation Solution | Curriculum |
| | EcoXpert Smart Grid, Sales, Proficient: Grid Operations Solution (test) | Test |
| | Tesys T drawer wiring with Ethernet 1 | Video |
| | EcoStruxure Building: MP-x Power Wiring | Video |
| | Discover Square D wiring devices: X series and XD series | Online Class |
| | EBO 2022: Advanced Engineering | Curriculum |

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| | EcoStruxure Power Automation System Engineering video tutorial – Electrical Design Overview | Video |
| | EcoStruxure Building: Value Based Selling 3.x | Curriculum |
| | Privacy by Design 2.0 | Video |
| | A Semi-Serious Internet Terminology and Slang | Curriculum |
| | Discover the Single unified experience in HVAC | Video |

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|---|---|---|
| | Maximize Profitability and Operations Efficiency 3/3 | Video |
| | Academy Virtual Training (SE South Africa) | Video |
| | EBO 2023: Engineering EBO Certification (Test) | Test |
| | EBO 2022: Installation of EcoStruxure Building Operation (Test) | Test |
| | Digital services & robotics in CPG packaging for Greater efficiency | Video |
| | Advanced Electrical Safety | Curriculum |
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| | Application | |
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| | Ref :Applications letter number : 2023/1226 | |
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| 123 FRANCIS BAARD STREET PRETORIA | | |
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| TEL:0123235618 | | |
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| ENQUIRY NUMBER: | | |
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| DHET : | | |
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| DOCKET NUMBER :2023/1226 | | |
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| -ID: NUMBER: TIRC0G000910610 | | |
| -REGISTRATION NUMBER: STUDENT - CO70040101099 | | |
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| -SARS VAT NUMBER: 923228238 | | |
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-MERSETA : 17_QA/ACC/1311/17

-SAQA REGISTRAR
STUDENT NUMBER:210020223812,20040
07064382.

-email adress: tshingombekb@gmail.com

-Alternate email address:
tshingombefiston@gmail.com

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| APPEAL DECISSION  RESULT RELEASE: | | |
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| Dear .mr minister of education dhet and deputy member of dhet .tvet college examination directorat and authority competencies. Governments  president | | |
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I' mr tshingombe tshitadi ;acknowledge student st peace college candidat examination career student follow course in duty of nated in rsa 2019 to 2024 , i 'm appear to your department goverment institution for allegation view no result of statement id candidat engineering n1.,n2, n,3,n4 ,n3 and n diplomat saqa outcom in irregularity final n5.n6 /nqf 6.

examination national examination was not delivery in the time external assessments commited irregularities.

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| 1.my motivation and disciplinairy assessment submitted my portofolio on line portal dhet release resultat statement and finalized award diplomat by examination commited irregularityb november invalide subject n3 trade theory electricakbtranscript the result of assessment was note release reson irregularity n3.subject n4 .subject fail druip result february 2022 .directorat assessment trascript material .statement affidavitsubmitted st peace college registrar shalom technical and afric instirut college no result outcom .after 15 days was result scaling n1.n2.n3but statement didint come out not print out by registrations resonement inconveniant. Arbitrary irregularity on february i submitted topics saqa qcto dhet email result of saqa documentation; filing dbe dhet .the commited was under investigation soon to finalyse . | | |

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| 2. I received to dhet committed<br>assessment examinations irregularities<br>the retain | | |
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| 3.allegation result statement  retain dhet .;saqa n diploma n diplomat application for n4.6 diplomat final was no granted n4.level 4 diploma icass years college in my portofolio submitted on line marked exam n5.n6.subject additional assessment information  by institution isat icass. | | |
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| Saqa accepted only qualifications official examination body country ..external examination based , 26 july 2022. | | |
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| 4.allegation to qcto retain on ;<br>saturday22 january 2022. ; with regard n<br>certificate direction dhet education<br>training (for n4_n6 n diploma or umalusi<br>n3 can not assist with qcto issued | | |
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| - i receiving Allegation to saqa retain on.10 march 2023 procedure for evaluatiin pro forma invoice .copy id passport.copy final award graduation certificate. Copy of completed transcript mark sheet academic record.proof payment if not meetings requirements can resubmitted again.non compliant; 27 july 2021 application above doe s not meet saqa | | |
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| Final award school diploma degre certificate in 48h . | | |

-that my requested letter to the authority minister for my result statement certificat  over the date review n diploma 24 month.18 month nated examination to resolve problem after examination irregularities materiel that final result n4 and new re certificate body insurence investigation result center assessment outcome  years icass total tvet  for my instirut st peace college institu  and externsl certificate n1.n3  afric training institut and shalom technical  collection print out was not in my application for diploma response from dhet  submitted to resolve conflic assessment examination.

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Sign :Tshingombe Tshitadi

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An.n3 .in the relevant specialization area communication nqf level 4 in language teaching ..theoretical knowl2 and practical skills required and learning of institution offering . To be award the award qualification  learners are to choose  complete .business studie 0.5 years business studies .

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N diploma  360 credit  .180 awarded to experiential training  business studie ..programme code n diploma engineering studie .electrical engineering. NQF qualification ID: 90674 .national engineering  studies electrical engineering. NQF level 6; 360 credit credit . Saqa learning  programme . N .

tshingombe fiston <tshingombefiston@gmail.com>

Wed, Feb 7, 9:29 PM (5 days ago)

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tena.m, lutuka.m, president,
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Appeal .process  academics

Section

-Student Name:tshingombe tshitadi

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| -Qualification : saqa record academic<br>institution name: foreign .st peace | | |
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| -college name: st peace college | | |
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| -Year of graduation:2020 to 2024 | | |
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| Policy st peace college quality system<br>manage qms | | |

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| - referral registrar attandance :Record irregularities material transcript and script submission statement and evidence years 2022 ,11 months feb 2023 register roll academics college basic and advance nqf policy criteria | | |
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| 1.Letter record academic and transcript academic : | | |

Consenting :asking to provide detail fir
reasin course attended topics  mark
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.-FROM:TSHINGOMBE TSHITADI

TO: THE DHET DEPUTY MINISTER  .
MEMBERS OF ACADEMIC RECORD

SAQA AND COLLEGE RECTORAT
INSTITUT

SUB : Dear : my name is tshingimbe and i attended event from to in there rwite to request for my transcript to apply for futher aduation i wish to express my sincer gratitude to your education i wish to express my sincer gratitude to your dhet college thing which have helped me in my profession. I wish to take studies at foreign institut saqa and college education advanced field continuing assessment professional institution has requirements a full transcript from my former studies to check my eligibility to studie the course i hope saqa to start my studie on and the dealnje to submit the the requested document is kindlt send the transcript at your earliest so that i an submjt the documents on time i herbrey provide my student identif6 number end of birbe you access my file quickly kindlt send the transcrip to my home please t .

-in effect of irregularities transcript material februarie 2022 need submission statement dhet full completion and finalise marks out term that honor for me to be part of this excellent institution since mention period feel proud and privileges to informer that due to the high standards of education imported by this institution secure institution workplace soon noining process i would be great ful to you if you colomb sending me the requested do i graduation years .

I hereby requested foil transcrip i eas students in journes from i graduate alumn of estemed successful career engineering experience cvs on line student research.

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| Ref: to maintaining record of academic achievement dhet .st peace college in saqa in order to maintaining acurate system student record lesson transcript student . | | |
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-student record : attendance  dhet and nated  years  and saqa years entry national frameworks qualification award degre diplomat  graduation. Enrol course in st peace college.

-academics  performance record keep track ..studdnts progress formal and informal assessment .portofolio

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| Topics system | | |
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| -Authors :tshingombe tshitadi: loyality | | |
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| research papper college system.<br>Management | | |
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Thank u for sincerely.

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| | Course in circulum | Weighting of courses | | | |
| | Industrial electronics n1 | | | | |
| | Engineering drawing n1 | | | | |
| | Electrical trade theory n1 | | | | |
| | Mathematics n1 | | | | |
| | Industrial electronics n1 | | | | |
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| | Mathematics n1 | | | | |
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| | N2 SCALING PLACEMENT | | | | |
| | Industriel electronics n3 | | | | |
| | Electronical trade theory n3 | | | | |
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| -plant operation theory n3 | | | | | |
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| Engineering drawing | n1 | | 0.33 | 1 |
| Electrical trade theory | n1 | | 0.33 | 1 |
| Mathematics n1 | | | 0.33 | 1 |

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| | N2 SCALING PLACEMENT | | | | | | |
| | Industriel electronics n3 | | 0.33 | 1 | | | |
| | Electronical trade theory n3 | | 0.33 | 1 | | | |
| | Enginering science n3 | | 0.33 | 1 | | | |
| | Electro- technology n3 | | 0.33 | 1 | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | 0.33 | 1 | | | |
| | | | | | | | |
| -Industrial orientation | n3 | | | | | | |
| | | | | | | | |
| -plant operation theory | n3 | | | | | | |
| | | | | | | | |
| -electro –technology | n3 | | | | | | |
| | | | | | | | |
| -electrical trade theory | n3 | | | | | | |
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| | | | | | | | |
| Electrotechnichnics n4 | | | | | | | |
| Industrial electronics n4 | | | | | | | |
| Enginering science n4 | | | | | | | |

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|---|---|---|---|
| Mathematics n4 | | | |
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| Subjects/ course circulum | | weight | Scale topic/ tot | credit | N |
|---|---|---|---|---|---|
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| | | | COMPLETED | | Diploma |
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| | | | YEARS / HOMEWORK | | Nqf |
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| | | | CLASS WORK | | 360 credit |
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| | | | | | 360 |
| Industrial electronics | n1 | - | 100% ; 100% | 0,30 | y |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Engineering drawing | n1 | - | 100 %; 100% | 0,30 | | | |
| | Electrical trade theory | n1 | - | 100%; 100% | 0,30 | | | |
| | Mathematics n1 | | | 100% ; 100% | 0,30 | | | |
| | | | | | 0,30 | | | |
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| | Industrial electronics | n1 | -,- | 100% ; 100% | 0.3 | | | |
| | Electrical trade theory | n1 | -,- | 100 %; 100% | 0.3 | | | |
| | Mathematics | n1 | -,- | 100%; 100% | 0,30 | | | |
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| | | | | | | | | |
| | N2 SCALING PLACEMENT | | | | | | | |
| | Industriel electronics | n3 | | 100%; 100% | 0.3 | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Electronical trade theory | n3 | | 100%; 100% | 0,30 | | | |
| | Enginering science | n3 | | 100%; 100% | 0.3 | | | |
| | Electro- technology | n3 | | 100%,100% | 0.3 | | | |
| | | | | | | | | |
| | | | | | | | | |
| | -Industrial orientation | n3 | | | | | | |
| | | | | | | | | |
| | -plant operation theory | n3 | 48% | 100% ;148% | | | | |
| | | | | | | | | |
| | -electro –technology | n3 | 19% | 100% ;119% | | | | |
| | | | | | | | | |
| | -electrical trade theory | n3 | 55% | 100% ;155% | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 27% | 100% ;127% | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | Electrotechnichnics | n4 | 18% | 100% ;118% | 0.3 | | | |
| | Industrial electronics | n4 | 19% | 100% ;119% | 0.3 | | | |
| | Enginering science | n4 | 35% | 100% ;135% | 0.3 | | | |
| | Mathematics | n4 | 30% | 100% ;130% | 0.3 | | | |
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| | Sub total credit qualifie | | 251% | 1900 %; 1751% | | | | |
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| | Award certificate diplomat | | | | 0.30x16 | | | |
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| | Irregularity final mark | | | | | | | |

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| | Subject : n3,n4,n5,n6 | | | | | | |
| | Scrip material evidence low assessment | | | | | | |
| | Progress marker | | | | | | |
| | N3 final certificate | - | | | | | |
| | Electronical trade theory | n3 | | 100% ,100% | 0.3 | | |
| | Electrotechnichnics | n4 | - | 100% ; 100% | 0.3 | | |
| | Industrial electronics | n4 | - | 100% ; 100% | 0.3 | | |

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|---|---|---|---|---|---|---|---|---|
| | Enginering science | n4 | - | 100% ; 100% | 0.3 | | | |
| | Mathematics | n4 | -- | 100% , 100% | 0.3 | | | |
| | Electrotechnichnics | n5 | - | 100% , 100% | 0.3 | | | |
| | Industrial electronics | n5 | - | 100% ; 100% | 0.3 | | | |
| | Enginering science | n5 | - | 100% ; 100% | 0.3 | | | |
| | Mathematics | n5 | - | 100% ; 100% | 0.3 | | | |
| | Electrotechnichnics | n6 | - | 100% ; 100% | 0.3 | | | |

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|---|---|---|---|---|---|---|---|
| Industrial electronics | n6 | - | 100% ; 100% | 0.3 | | | |
| Enginering science | n6 | - | 100% ; 100% | 0.3 | | | |
| Mathematics | n6 | - | 100% ; 100% | 0.3 | | | |
| Total rate | | | 1300% +1800; | | | | |
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| ELECTRICAL , | | | 100% | | | | |
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| ACREDITTION N DIPLOMA , | | | | | | |
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| ID 67109 N , N1 ID 673575.N3 ID 66881, ID 66960, ID 67005 | | | | | | |
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| Required information | Submitted yes not | Institut comment | For officer only |
|---|---|---|---|
| Annuel report form | yes | Good years | |
| | | Award | |
| Termination of agreemnt with othor institut | yes | Good years | |
| | | Award | |
| The disclosure certificate as issued by | yes | Good years | |
| the CIPC for Directors who have | | | |
| | | Award | |

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|---|---|---|---|---|---|---|---|
| | - INSTITUT COLLEGE NAME :ST PEACE COLLEGE | Yes | Good years | | | | |
| | | | | | | | |
| | -ID: NUMBER: TIRC0G000910610 | Yes | Award | | | | |
| | | | | | | | |
| | -REGISTRATION NUMBER: STUDENT - CO70040101099 | Yes | | | | | |
| | | | | | | | |
| | -SARS VAT NUMBER: 923228238 | Yes | | | | | |
| | | | | | | | |
| | -MERSETA : 17_QA/ACC/1311/17 | Yes | | | | | |
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|---|---|---|---|---|---|
| -SAQA REGISTRAR<br>STUDENT NUMBER:210020223812,20040<br>07064382 | Yes | | | | |
| | Yes | | | | |
| | yes | | | | |
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Show Navigation Menu

Completed Training: Tshingombe fiston

| Title | Type |
| --- | --- |

| | | |
|---|---|---|
| | Maximize Profitability and Operations Efficiency 2/3 | Video |
| | SDL V2 Developer Role | Video |
| | DirQ_GL13R7 Managing Offer Safety Risks | External Content |
| | Discover Zelio Control Relays | Video |
| | Schneider Electric’s Vision Edge 2022: Powering Digital Transformation | Video |
| | Secure Power_Virtual Certification_on demand 2021_sesion 4 | Video |
| | Cooling Virtual Certificaion_on demand 2021_sesion 2 | Video |

| | | |
|---|---|---|
| | Technical Expert Assessment Video | External Content |
| | DirQ_GL36R00 Technical Expert Assessment | External Content |
| | Technical Expert Assessment Workflow | External Content |
| | Technical Expert Assessment GuideBook | External Content |
| | Schneider Electric Information Technology guide | Material |
| | Heating, Ventilation and Air Conditioning (HVAC): Discover the Machines | Online Class |

| | | |
|---|---|---|
| | Room Ventilation And Airborne Disease Transmission In A Healthcare Setting | Online Class |
| | Ecostruxure Power: Energy Modeling and Verification (SSOW) | Video |
| | Vérification de la facture /EcoStruxure Power: Utility Bill Verification (French) | Online Class |
| | Discover Telemecanique Sensors | Curriculum |

| | | |
|---|---|---|
| | EcoStruxure Power Operation: Ch7 - Add Mechanical Graphincs and Controls | Video |
| | ASCO: Fundamentals in Technical Document Review | Online Class |
| | EBO 2023: Introduction to Docker | Online Class |
| | EcoStruxure Security Expert: Biometric Reader Integration 4.3 | Video |
| | Discover Harmony XB5S Biometric Switches | Video |

| | | |
|---|---|---|
| | EcoStruxure Building: LonWorks Introduction Part 3 | Online Class |
| | Innovation Talk: Why Alarm Management is the tip of the iceberg- and the best indicator of a poorly performing control system | Video |
| | PowerTalks: Equipment Performance | Video |
| | EcoStruxure Building: Script Programming (Self-Study) | Material |

| | | |
|---|---|---|
| | Drives: Fundamentals of Kinematics:<br>Calculation Centrifuge | Video |
| | Gestion de la Capacité /EcoStruxure<br>Power: Capacity Management (French) | Online Class |
| | ASCO: Low Voltage Construction<br>Fundamentals | Online Class |
| | Migrate from Legacy Graphics | Video |
| | Physical Infrastructure Management<br>Basics | Online Class |
| | Fundamentals of Physical Security | Online Class |

| | | |
|---|---|---|
| | Schneider Electric Approved EV Installers<br>: IT Architecture | Material |
| | Advanced Lighting Control with KNX and<br>DALI | Online Class |
| | ASCO: Application of Circuit Breakers in<br>Power Control Systems | Online Class |
| | Security Expert Transition Guide | Material |
| | Discover Wiring Devices: Technical<br>Structure and Applications | Online Class |

| | | |
|---|---|---|
| | Internet: 50+ Years of Innovations and Inventions that Made It | Curriculum |
| | Computer History in a Photo Album | Curriculum |
| | Digital Economy: Movers and Shakers | Curriculum |
| | Your Computer’s Secrets | Curriculum |
| | Trending Digital Technologies | Curriculum |

My Courses: Tshingombe fiston

Use the transcript to manage all active training.

0 HRS

AGGREGATE TRAINING COMPLETED

FISCAL YEAR ENDING

12/31/2025

COST

R0.00

Filter by Training Status

Completed

Sort by

Completion Date

Filter by Training Type

All Types

Search by Keyword

Search

Search Results (42)

Maximize Profitability and Operations Efficiency 2/3

Completed : 9/20/2024 Status :
Completed Training Type : Video
Training Status : Completed

| | |
|---|---|
| SDL V2 Developer Role | |
| Completed : 9/20/2024 Status : Completed Training Type : Video | |
| raining Details | |
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| | Training Type: |
| | Provider: |
| | Version: |
| | Training Hours: |

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| Description: |
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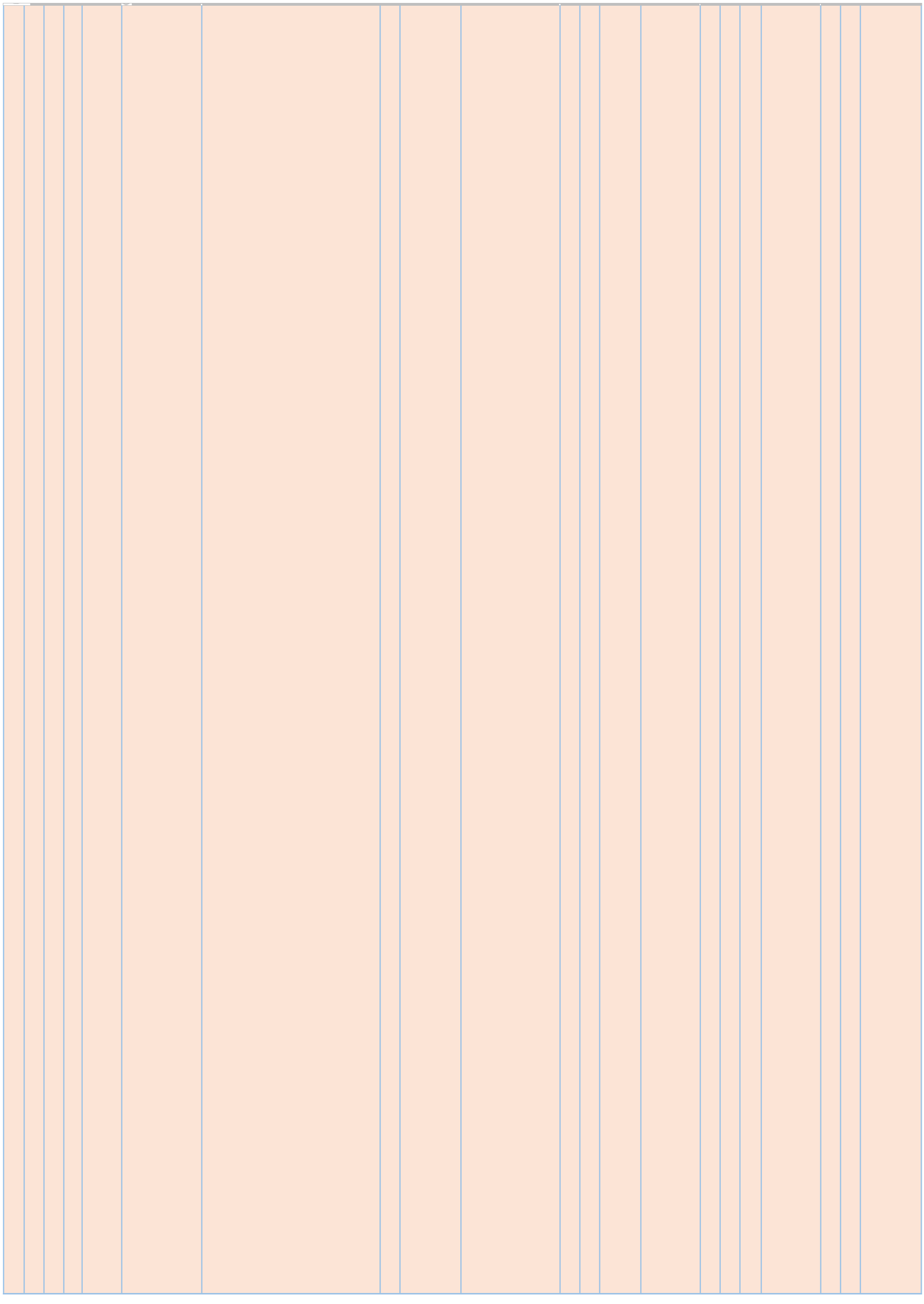
Status:

Training Purposes

Due Date:

Expiration Date:



TRAINING TRANSCRIPT FOR
TSHINGOMBE TSHITADI

List of completed activities from
3/10/2024 to 3/10/2025

**Username:**

tshingombefiston@gmail.com

**E-mail:**

Analyzing Reliability in the Data Center
Outline

Course Description:

The growing reliance on information systems that operate 24 hours per day, 7 days per week, has

spawned a rapidly growing and developing industry that supplies products and services on

demand. The need for these types of information services now reaches into every business office

in the world. Unfortunately, events of all kinds including hardware failure, human error,

environmental changes, structural failure and external events, can lead to the possibility of

unanticipated systems downtime.

Modern data centers do not tolerate planned downtime and strive for no outages in a 10-year

mission. Data center operations staffs are faced with the dilemma of either downtime as a result of

insufficient physical infrastructure, or incurring extensive costs by designing in more redundancies

than is necessary. Targeted reliability solutions allow businesses to meet individual requirements of

the data center, while minimizing the total cost of ownership.

In fact, very high reliability is difficult to attain and redundant hardware is only part of the answer.

This course will demonstrate some important performance success factors and overviews best

practices for analyzing and optimizing reliability.

Course Outline:

Learning Objectives

At the completion of this course, you will be able to:

§ Define key terms associated with analyzing reliability risks

§ Identify some common cause failures in the data center

§ Describe the benefits of conducting a Probabilistic Risk Assessment (PRA)

§ Recognize the reliability advantages of utilizing scalable, modular architecture in the data center

Agenda

§ Introduction

§ Analyzing risk

§ Redundancy

§ Common cause failures

§ Probabilistic Risk Assessment (PRA)

§ Case study example

§ Summary

©2013 Schneider Electric. All rights reserved. All trademarks provided are the property of their respective owners.Course Content or Material:

1) Introduction

a) Information systems need to operate 24 / 7

b) Growing and developing industry supplies products and services on-demand

c) Modern data centers do not tolerate planned downtime and strive for no outages in a 10-

year mission

d) Data center operations staffs are faced with

e) The dilemma of downtime as a result of insufficient physical infrastructure

f) Incurring extensive costs by factoring in unnecessary redundancies

| | |
|---|---|
| | g) Targeted reliability solutions allow businesses to meet individual requirements of the data |
| | center, while minimizing the total cost of ownership |
| | 2) Reliability |
| | a) Understanding how to best define downtime risk |
| | i) Is important to optimizing its reliability |

ii) Decreases total cost of ownership

iii) Increases agility

b) Reliability metrics statistically analyze
the likelihood of a failure occurring

3) Redundancy

a) While redundancy can increase
reliability, there are significant costs and
potentially

serious drawbacks

b) A redundant system has more components

c) In general, systems with more components will experience more failures

4) Discussing Best Practices

a) The design, manufacture, operation, maintenance and repair of equipment

b) The gathering of data, and the review and publication of component benchmarking results

c) Consistent deployment of the language of reliability, both definitions and assumptions

d) A philosophy addressing the constant pursuit of root causes, common cause failures and

relevant data

5) Modularity and Component Count

a) Reliability can be increased through standardization

b) Modularity is a powerful concept

c) Modularizing a system can increase the number of internal components

d) Reliability analysis of modular systems must consider

i) Component design

ii) Function

iii) Dependencies

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a) Data center testing and maintenance practices often have a significant impact on systems

reliability

b) Testing and diagnosis can improve reliability, but may also degrade it

7) UPS: Historical Perspective

a) In most UPSs, utility AC power is rectified to DC

b) The inverter synthesizes an AC voltage free from the effects of spikes, sags, harmonics,

and brief utility outages

8) Assessing Reliability

a) Product support engineers

i) Track the products' performance in actual use

ii) Identify and implement changes necessary to correct deficiencies or defects

iii) Benefit from a road map identifying components most likely to fail

b) Deviations from the predictions of the road map would identify new areas for more

intensive investigation and possible remedial action

9) The Correct Course of Action: PRA

a) The process of building the logical model results in a comprehensive review

b) The mathematical nature of the calculation limits the logical fallacies that tend to dominate

qualitative evaluation of reliability

c) The implication is that if N components are required for success, there is one, two, twice

as many, or even twice plus one as many units available

d) Not all redundancy makes the same contribution to reliability

10) Reliability Assessment Case Study

a) The mathematical models that resulted from the analysis were used to answer some key questions

b) The scalable, modular system utilizes redundancy in nearly all components as a means of achieving high reliability

c) MTechnology, Inc's analysis showed that

d) There are both costs and benefits to redundancy

e) Some sub-systems benefit less from redundancy than others

f) Complex mathematical formulas were utilized to calculate the case study failure rates and

common cause failures

11) Case study goals

a) To identify potential sources of failure

©2013 Schneider Electric. All rights reserved. All trademarks provided are the property of their respective owners.b) To evaluate the potential for further improvement in the scalable, modular power system’s

reliability and availability

12) Target of Case Study Analysis

a) Subjects of analysis

| |
|---|
| i) 14 - 40 kW Scalable, modular, rack based power system with PDU and static bypass |
| |
| ii) 500 kW central UPS |
| |
| b) Tools utilized |
| |
| i) Probabilistic Risk Assessment (PRA) |
| |
| ii) Fault tree |
| |
| iii) Event tree analysis |
| |
| iv) Bayesian updating |
| |

13) Reliability Assessment Case Study

a) All actions have both beneficial and negative affects on reliability

b) It helps to support the uptime of the servers but also can represent a point of failure

14) Comparing Modularity to the Central UPS

a) The scalable, modular system loses power to all loads only when

i) The main entrance bus fails

ii) The transfer switch fails to open

b) The probability of all 14 scalable, modular units failing simultaneously due to internal

failures is extremely low

c) PDU failure will cause partial load drop

d) Only one circuit breaker after the transfer switch will cause all critical loads to fail

15) Central UPS data

a) Battery failure is a significant contributor of failure in central UPS

b) The central UPS can fail internally, and bypass can fail, causing all loads to fail

c) PDU failure will cause partial load drop

16) Reliability Assessment Case Study: The Findings

a) The calculated reliability of the scalable, modular power system is comparable to data

published by vendors of large, central UPSs

b) The scalable, modular power system is significantly less likely to suffer a complete system

failure

c) The redundancy provided in the scalable, modular power system definitely improves the

product's reliability

©2013 Schneider Electric. All rights reserved. All trademarks provided are the property of their respective owners.17) Conclusions

a) Overall, the scalable, modular architecture had a system failure rate was approximately

40% lower than that of the central UPS system

b) Failure is defined as the loss of power for all critical loads

c) Discounting battery failures, the scalable, modular failure rate is still approximately 18%

less than that of a comparable central UPS architecture

d) If failure is defined to include dropping of any single load due to a branch circuit failure, but

not UPS failure, the scalable, modular architecture is 6% less likely to fail

e) Scalable, modular power system architecture proved more reliable than the single module

| |
|---|
| UPS with a single battery string |
| |
| f) The redundant subsystems within the scalable, modular power system successfully reduced the probability of UPS failure |
| |
| g) The performance of the ATS is often the limiting factor in achieving higher reliability |
| |
| 18) Summary |
| |

a) Understanding how to best define downtime risk is important to optimizing its reliability,

while decreasing TCO and increasing agility

b) While redundancy can in principle increase reliability, there are significant costs and

potentially serious drawbacks

c) Data center professionals need to understand which processes are most critical, and

target reliability accordingly

d) PRA is a powerful tool when applied carefully

Course Assessment: Test Your Knowledge

Course Feedback: We Value Your Opinion

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An Introduction to Medical Gas and Vacuum Systems

Course Outline

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Course Outline

Course Description

This course introduces plumbing and discuss the various types of medical gas their purpose of these systems is to care provide safe and reliable support to the

Codes and standards are also discussed.

Course Objectives

- Discuss the purpose of plumbing and medical gas systems
- Identify the various types of medical gas and vacuum systems used in health
- Review the important codes and standards used for medical gas and

Course Content or Material

1. Introduction

a. Introduction to Medical Gas and Vacuum Systems

2. Types of medical gas and vacuum systems

a. Medical gas systems

i. Oxygen

ii. Medical Air

iii. Nitrous Oxide

iv. Nitrogen

v. Carbon Dioxide
vi. Mixed Gases
vii. Instrument air
b. Vacuum Systems
c. Medical/Surgical Vacuum
d. Waste Anesthetic Gas Disposal
e. Dental Vacuum Systems (Tim will write
script)
3. Codes, standards, regulations and
authorities having jurisdiction
a. NFPA 99
b. FGI Guidelines
c. Local or state regulations
d. Enforcement
i. Certificate of occupancy
ii. CMS and accreditation
e. ASSE Standards
4. Categories of medical gas and vacuum
systems
a. Introduction to NFPA 99 Categories
b. Category 1
An Introduction to Medical Gas and
Vacuum Systems
Course Outline
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c. Category 2
d. Category 3
Course Assessment: Test Your Knowledge

Course Survey: We Value Your Opinion

On Mon, Mar 17, 2025 at 10:39 AM
tshingombe fiston
<tshingombefiston@gmail.com> wrote:

We will be conducting system maintenance Sunday March 16, 2025 9:00 p.m.-11:00 p.m. EDT. Please note that you will not be able to login at this time.

Course Assessment - Results page

1

2

3

4

5

6

7

8

9

10

Question

A/n _____ measures the amount of electrical current flowing through a circuit during a specific time interval.

Ampere

Volt

Ohm

Watt

Question

Materials with _____ resistance require more voltage to make the electricity flow.

Lower

Higher

Slower

Faster

Question

True or false? The electrical load in a data center is the sum of the various pieces of data center equipment which consume and are supplied with electrical power

T

F

Question

The power in Watts is the _____ power drawn by the equipment, while Volt-Amps is called the _____ power.

Electrical, real

Apparent, real

Real, apparent

Real, solar

Question

A circuit breaker may need to switch short circuit currents as high as _____ times its rated current.

30

15

10

5

Question

Circuit breakers can fail in which of the following ways:

Failure to close, or failure to open under fault conditions

Spurious trip

Failure to operate with the time-current specifications for the unit

All of the above

Question

This form of standby power uses electromagnetism to produce electricity

a, Electrochemical generator

Battery

Fuel cell

Mechanical generator

Question

_____ occur when there is a varying quality of connections to the earth at different points in an electrical installation

Ground loops

Power factor corrected power supplies

Ground Fault Circuit Interrupters

Thermal-magnetic circuit breakers

Question

An approach to solve the problem of impulsive transients includes the utilization of which device?

Power Line Conditioners

| |
|---|
| Uninterruptible Power Supply (UPS) |
| |
| Voltage Surge Suppressor (TVSS) |
| |
| Modern harmonic-correction equipment |
| |
| Question |
| |

According to M Technology, Inc., what percentage of the time are circuit breakers involved in a power system failure in data center electrical infrastructure?

10%

40%

70%

50%

Course Assessment - Test

Course Assessment

Number of questions:

10

Questions are shown:

One by one

So far you have done this test 1 time

Previous unit: Online Course

1.4% completed

Lesson Fundamentals of Power

Course Overview - Passed

Online Course

Course Assessment - Current unit

Reference Materials

Course Transcript

Lesson Going Green: Energy Efficiency in the Data Center

Course Overview

Online Course

Course Assessment

Course Feedback

Reference Materials

Course Transcript

Lesson Building Controls I:
An Introduction to Building Controls

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Combined Heat and Power

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Compressed Air Systems I: An Introduction

Course Overview

Online Course

Course Assessment

Course Feedback

Reference Materials

Course Transcript

Lesson Energy Efficiency with Building Automation Systems

I

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Procurement I: Options in Regulated and Deregulated Markets

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Procurement II: Introduction to Hedging in Deregulated Markets

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Procurement
III: Balanced Hedging
Strategies

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Rate
Structures I: Concepts and
Unit Pricing

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Going Green with Leadership in Energy and Environmental Design

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Maintenance Best Practices for Energy Efficient Facilities

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Steam Systems I: Advantages and Basics of Steam

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Waste Heat Recovery

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Previous unit: Online Course

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10) Calculating Efficiency and Operating Cost

a) The technical design of the modular, scalable system results in a much higher rate running on lightly loaded UPS units

b) The Fortune 500 firm in our case study:

i) Chooses to implement redundant UPS systems and operates each of them at

capacity
ii) Chooses the "install as you grow
differences in energy savings, and
therefore, lower electrical bills
17) Total Cost of Ownership
a) Capital costs
i) Allow for an initial build out of 27 watts
ii) Assume a build out to 80 watts per
square foot for an additional 5 years
b) Electrical costs
i) Load levels will be at 80% of 2 (N+1)
ii) The maximum loading on any one
system is 40%
c) Service costs
i) Customer requires 7x24
ii) 4 hour response
iii) 100% coverage on parts and labor
iv) Battery maintenance will not be
included
18) Key TCO Components of Payback
19) Summary
a) The green data center features a safe
and healthy work environment and
energy efficient manner
b) Five examples of green approaches in
the data center include the cooling use of
cross, ngnuzed solutions, cooling
c) TCO analyses can justify investments in
green technologies

Course Assessment: Test Your Knowledge

Course Feedback: We Valu

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Fundamentals of Power Outline

Course Description

Power is the foundational cornerstone in
downtime, software and data corruption,
imperative that servers are insulated
electrical problems. This course will
explore the topic of power, and how it is
center.

Course Outline:

Learning Objectives

• Identify basic electricity concepts

• Describe electrical power and its conversion
• Differentiate between various power usages in a data center
• Define power factor
• Recognize the importance of electrical safety in power distribution
• Identify potential problem areas in the data center

Agenda

• Electrical power key terms
• AC and DC power
• Power factor
• Volt configurations, plugs and receptacles
• Circuit breakers and convenience outlets
• Seven common electrical problems
• Components in a data center

Introduction

1) Key Terms

a) Volt (V)
b) Ampere (Amp)
c) Ohm (Ω)
d) Hertz (Hz)
e) Alternating Current (AC)
f) Direct Current (DC)
g) Load

2) Single-phase and 3-phase Power

3) Watts and Volt-Amps

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4) Power Factor Correction

a) Power factor of nearly 1
b) Method of offsetting inefficiencies created by electrical loads

5) Plugs and Receptacles

a) The most common plug/receptacle combination for IT equipment is of an IEC
b) Also common are plugs and connectors of the twist-lock variety
c) International Electro-technical Commission Plugs
d) National Electric Manufacturers Association Plugs

8) Circuit Breakers

a) A type of switch
b) Designed to protect electrical equipment from damage caused by
c) Designed to trip at a given current level

9) Circuit Breaker Protection

10) Circuit Breaker Sizing

11) GFCI, ELCB, and RCD

a) Ground Fault Circuit Interrupters (GFCI), Earth Leakage Circuit Breakers or Residual-current devices (RCD) trip a circuit if they detect a small amount of current
b) Larger data centers use resistor banks instead of GFCI, ELCB, or RCD

12) Convenience Outlets

a) Used for non-computer devices

b) Allows for other non-computer equipment to be plugged in without
13) Grounding
a) Safety measure to protect against electric shock
14) 7 Power Problems
a) Impulsive Transients
b) Interruptions
c) Sags and Undervoltages
d) Swells and Overvoltages
e) Waveform Distortion
f) Voltage Fluctuations
g) Power Frequency Variation
15) Standby Power and Distribution
©2021 Schneider Electric. All rights reserved. All trademarks provided per the
a) Any power source available to the data center that supplies power when utility unavailable
16) Power Distribution Components
a) Primary power source (Utility)
b) Emergency power source (Generator)
c) Circuit/Branch Circuit
d) Uninterruptible Power Supply (UPS)
e) Automatic Transfer Switch
f) Power Distribution Units (PDU)
g) Outlet Strips
h) Server Plug
17) Summary
a) Power infrastructure is critical to
b) Understanding basic power terms
battery, standby power equipment, and
c) Failures can occur at various points in
given to the construction and commissioning
d) Numerous power anomalies exist that
e) Understanding the threats and ways
applying practical power solutions can
Course Assessment: Test Your Knowledge
Course Feedback: We Value Your
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i. The controlling variable is affected by the actions of the controlled device upon the controlled variable
c. Cascading
i. Used to modify the performance of closed control loops when required
5) Red Wire & Direct Digital Controls
a. DDC
i. More sophisticated system
ii. Use electronic controllers that support multiple control loops
b. Enable / disable control
i. Another form of electronic control
ii. Simply turns another controller on or off

iii. One controller will determine when another controller is able to perform its function

6) Summary

a. For an environmental control system to effectively maintain a building, thereby occupant comfort, three things must take

i. Data must be measured and provided

ii. Measured data then can be compared to a set of desired outcomes or instructions

iii. An output is produced based on the measured data to change or maintain the environment

b. A simple control loop is defined as one control logic, which provides an output to

c. Inputs and outputs may be analog or digital

d. A controller may contain many control loops, and a control system may contain many controllers

e. There are three types of control loops

i. Open

ii. Closed

iii. Cascading

f. And there are three common control technologies

i. Pneumatic

ii. Electrical, and

iii. Electronic

g. Electronic controls may be

i. Direct Digital Control, called DDC, or

ii. Enable / Disable Control

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Combined Heat and Power (Cogeneration)

Course Description: Cogeneration today

production of heat and power

a single thermodynamic process. The

to applying technologies to the function

and construction of deployment of the

cycle plants including combined

Prerequisites for this course include:

Energy Rate Structures Level II

Learning Objectives:

At the completion of this course, you will

• Define what cogeneration is along with

• Identify the different approaches for

• Discuss the various factors to consider

when evaluating the use of a CHP plant

Course Content or Material

1) Introduction

a) Technology overview

b) Defining “cogeneration”

i) How cogeneration occurs

ii) Primary fuels used

2) Two main approaches for cogeneration
a) Topping cycle plants (including Combined Cycle plants)
i) Examples
ii) Overview
b) Bottoming Cycle Plants
i) Examples
ii) Overview
3) Environmental Issues
a) Benefits
b) Concerns
4) Things to Consider When Applying CHP Plant
a) Steam load versus electric load
b) Capital utilization / productivity
c) Reliability requirements (steam and electric)
d) Local electricity rates
e) Efficiency gains versus fuel prices
f) Fuel availability and selection
g) Staffing and training
5) Comparing CHP Technologies
a) Diesel engine
b) Natural gas engine
c) Steam Turbine
d) Gas Turbine©2023 Schneider Electric. All rights reserved. All trademarks
Compressed Air Systems I: An Introduction
Course Description
Compressed air is widely used throughout industry, right alongside electricity, gas and water. From mining, production to small manufacturing plants and represent the majority of the facility's compressed air, reliability is paramount, but consumption by 20% to 30%, energy is lost. This is the first in a series of compressed we will introduce the relative inefficiency of compressed air and examine the air system.
Course Outline
Course Objectives
Objectives
• Explain basic compressed air terms and
• Describe the relative inefficiency of
• Define the supply and demand sides of
• Identify the components of a compressed air system and explain what
Course Content or Material
1) Introduction
2) Supply & Demand
a. Divided into a supply side and a demand side
3) Compressed Air Pros & Cons

4) Compressed Air Inefficiency Examples
a. Metric Unit Example
b. US Customary Unit Example
5) Compressed Air Systems Optimization
a. The efficiency of compressed air
systems is directly related to operation
i. Systems are not well understood by
ii. Improving a system is perceived as a
risk to production
iii. Vendors compete in a market where
price, without regard for the cost of
operation
b. Optimization leads to
i. Reduced costs
ii. Reduced maintenance
iii. Less downtime
iv. Increased production
v. Improved product quality
6) Equipment Descriptions
a. Fan
b. Blower
c. Compressor
7) Pressure Terminology
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a. Pressure
b. Absolute Pressure
c. Gauge Pressure
8) Standard Volume of Air
a. Metric
b. US Customary
9) Volume Flow
a. Inlet flow
b. Actual flow
c. FAD
d. Standard flow
e. Capacity
10) Operating cost
a. Proportional to volume
b. Proportional to pressure ratio
11) Dew Point
a. The temperature at which
condensation begins to occur
12) Compressed Air Requirements
a. Cleanliness
b. Dryness
c. Oil content
13) Compressed Air System Components
a. Interactive element
14) Summary
a. Basic compressed air terms and
concepts:

b. Compressed air as a source of power is relatively inefficient. However, it can be useful and necessary at times;
c. Compressed air systems are normally broken down into supply and demand components;
d. You should now be able to identify basic components of a pneumatic system and explain what they do

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Energy Efficiency with Building Automation Systems Part 1

Course description:

In this course we will focus on what a building automation system (BAS) is and some of the commonly used terminology. We will also look at some of the HVAC strategies used in automation systems.

Course Outline:

Learning objectives

At the completion of this course you will be able to:

- Define what a building automation system is
- Review the main terminology and components of a Building Automation System
- List the most common HVAC strategies that may be controlled by a Building Automation System

Course content or material

1) Introduction
a. What is building automation
b. What are the functions of building automation systems (BAS)
2) Parts of a BAS
3) Terminology
a. Set point
b. Air
4) Review of HVAC systems
a. Equipment
i. Air handling unit
ii. Chiller
iii. Cooling tower
iv. Flow controller
v. Boiler
vi. Dual duct
vii. Constant volume/variable temperature
viii. Variable air volume
ix. Terminal reheat

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Energy Procurement I

Course Description: The procurement of becoming a major part of the energy understanding of the market, regulatory The purpose of this course is to raise awareness of the available options for

Learning Objectives:

- Define the roles of the main players in the energy chain
- Explain the major differences in regulated and deregulated markets

- List the main options available for optimizing energy procurement

Course Content or Material:

1) Introduction

2) Types of Energy Typically Procured

a) Most common electricity and natural

b) Coal, Oil-based fuels, Steam, Compressed air

3) Energy Supply Chain

a) Production, Transmission, Distribution, Supply

b) Gas supply chain

c) Electricity supply chain

4) Regulated and deregulated markets

a) Regulated Markets

b) De-regulated Markets

c) Wholesale versus Retail

d) Equal access to transmission and distribution

e) Drivers of Deregulation

f) Pricing

i) in a regulated market

ii) in a deregulated market

g) Options in a regulated market

i) Natural gas contracts

ii) Power contracts

h) Options in a deregulated market

i) Supplier Options

i) Local distributor

ii) Gas or power marketers

iii) Brokers

iv) LDC Marketing Departments

v) Aggregator

vi) Power Pool and Exchange Operators

vii) Overview of Supplier Options

viii) Pipeline Connects for Large Consumers

5) Procurement pitfalls

a) Exposure to energy price volatility that

b) Energy that is managed locally with no

c) Procurement decisions that are made by personnel without knowledge of the market

d) Contracts renewed based on

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e) Contract renewals that embedding the

f) A conviction that hedging is speculative

g) Deregulation Growing and Prices are Volatile

a) Hedging

b) Avoiding pitfalls of lowest price and highest risk

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Energy Procurement II

Course Description: Unprecedented volatility in today's energy markets has

havoc on the profit margins and bottom
successfully manage costs in this market,
purchasing strategies—or as it is based
price risk management and hedging
mitigate the impact of these events on
management program can provide risk
earnings from the unpredictable effects
course is to address the hedging process.
Markets as well as fixed and indexed
Prerequisites: Energy Procurement I:
Options in Regulated and Deregulated

Learning Objectives:

At the completion of this course, you will
• Explain the difference between spot
• Describe how hedging reduces your
• Define the meaning of fixed and index-
linked contracts

Course Content or Material

1) Introduction

a) Brief overview of gas and electricity
markets

b) Energy procurement

2) Procurement Pitfalls

a) Common pitfalls in a deregulated
market

b) How energy managers remedy
common errors in energy procurement

3) Commodity Markets for Energy

a) Commodity exchanges

i. The New York Mercantile Exchange
(NYMEX)

ii. The Singapore Commodity Exchange
(SICOM)

iii. The former International Petroleum
Exchange (IPE), bought and now part of Intercontinental Exchange
(ICE)

iv. Over The Counter

b) Energy buyer options

i. Spot market

ii. Forward market

i. Fixed contract

ii. Index-linked contract

4) Determining Energy Prices

a) Total energy costs

b) Regulated cost components

c) Commodity-based market purchasing

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5) Avoiding Pitfalls of Lowest Price and
Highest Risk

a) Define energy purchasing strategy

i) Spot purchasing versus fixed price
purchasing

ii) Hedging

6) Implementing Hedging

a) Forward contracts

b) Futures market

c) Flattening a position
d) Trading forward contracts
e) Permutations
f) Contract expiration
g) Imbalances upon delivery
7) Hedging Examples
a) Hedging on the forward market
b) Settling contracts on the spot market
8) Fundamental Concept of Hedging
a) Shaves off the extremes
b) Provides predictability
9) Adopting a Balanced Approach to Hedging
a) Full requirements fixed-price
b) Partial fixed-price
c) Partial spot market
d) Staggered fixed-price

energy procurement in balanced electric

Course Description: Managing energy and volatility are many industri
cts market, it is important to apply a
approach with quantity exposure to and
events on financial results. The purpose
strategies, and identify the main drivers
commodity market functions to support

Pre-requisites: Energy Procurement I and Energy Procurement II

Learning Objectives:

At the completion of this course, you will be able to:

- Describe a variety of balanced hedging strategies
- List the main drivers of energy price
- Describe how commodity markets function to support energy trading

Course Content or Material

1) Adopt a Balanced Hedging Strategy
a) Brief overview of concepts covered in Energy Procurement II
i) Full requirements fixed-price
ii) Partial fixed-price
iii) Partial spot market
iv) Staggered fixed-price commitments
b) Determination requirements
i) Commitment term
ii) Tolerable price levels
iii) Range of tolerable cost fluctuation and
iv) Minimum/maximum time horizons for
v) Plan of action to mitigate damage for when prices change rapidly
2) Risk Tolerance
a) Definition of hedge ratio
b) Defining risk tolerance

3) Defining a Hedge Ratio and Strategy
a) Riverbanks analogy
b) Examples of hedge ratio and energy purchasing strategies
4) Exchange Operation
a) How commodity exchanges function
b) Commodity exchange regulation
c) Commodity-based market purchasing strategies
5) Terms and Mechanisms
a) The short position – which means you are agreeing to sell
b) The long position – which means you are agreeing to buy
c) The price of the contract
d) The daily account adjustment
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e) The final settle price
f) The strip
g) Futures market versus the stock market
h) Final settle
6) Drivers of Energy Prices
a) Supply
b) Demand
c) Seasonality
d) News and Rumors
e) Speculators
7) Commodity Risk Analysis
a) Role of gas and power marketers
b) Role of independent market analysis service providers
8) The Forward Curve
a) Definition
b) Examples
9) Price Forcasting
a) Definition
b) Examples
10) Other Procurement Considerations
a) Price, dependability and service
b) Importance of considering
11) Best Practices
a) Integrates on a continual basis
i) Data
ii) Risk management
iii) Procurement
b) Employs
i) Data driven decisions
ii) Management approach that identifies and quantifies risk before determining the best way to manage it
iii) Procurement optimisation with operations

12) Summary

10) Summary

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Energy Rate Structures Part 1: Concepts and Unit Pricing

Course description:

Understanding the forms of energy used is key to understanding energy costs and understanding what you are paying for, you can adopt different strategies for and be able to move to a different rate structure we will focus primarily on gas and electricity concepts and unit pricing. In this

Course Outline:

Learning objectives

At the completion of this course you will be able to:

- Define and recognize the difference between different forms of energy
- Flat rates, block rates, seasonal pricing, time of use rates, and real time pricing

Course content or material

1) Introduction

a. Understanding different forms of energy

2) Consumption and Demand

a. Difference between consumption and demand

b. Example

3) Energy Pricing

a. Types of energy pricing

i. Flat rate

ii. Block rate

1. Declining

2. Inverted

iii. Seasonal rates

iv. Time-of-Use rates

1. On-peak

2. Off-peak

3. Shoulder/Mid-peak

v. Time of use rates

vi. Real Time Pricing

vii. Other forms of pricing©2023 Schneider Electric. All rights reserved.

Going Green with Leadership in Energy and Environmental

Design Course Outline

Course Description:

This course defines green buildings, building council and the requirements of the Environmental Design (LEED) rating meeting the LEED requirements will also be explained.

Course Outline:

Learning Objectives

At the completion of this course, you will be able to:

• Define the characteristics of Green Building

• Explain the mission of the US Green Building Council

• Identify the Leadership in Energy and Environmental Design (LEED) rating system

• Describe Schneider Electric products and services which satisfy LEED requirements

Agenda

• Introduction

• Impacts of US Buildings on the Environment

• Advantages of building green

• Review the Mission of the US Green Building Council

• Discuss the LEED rating system

• Discuss Schneider Electric products and services that satisfy LEED requirements

• Introduce Case Studies

• Summary

Course Content or Material

1) Introduction

a) Green Building

b) Design of Leadership in Energy and Environmental Design (LEED)

c) Who makes up the LEED team

d) LEED reach

e) Point of the LEED point based system

f) Why is there a demand

2) Impacts of US Buildings on the Environment

a) Impacts of US buildings on resources

b) US Energy Consumption

c) US Electricity Consumption

3) Advantages of Building Green

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a) Demand for Green Building

b) Perceived Business Benefits

c) Predictions in growth of Green

d) Next Generations impact of perceptions of green build

4) Mission of USGBC

a) Mission statement for USGBC

b) What the USGBC does

c) Membership

5) LEED Rating System

a) LEED addresses complete lifecycle of buildings

b) 4 Levels of LEED
c) 6 Credit Categories
d) Steps to LEED Certification
e) A sample checklist
f) Available resources on line
g) Schneider Electric products and services that satisfy LEED requirements
a) Maximizing LEED points
b) Building Automation and Control
c) Critical Power and Cooling
d) Engineering Services
e) Field Services
f) Lighting and Lighting Controls
g) Power monitoring
h) Variable Frequency Drives
i) Renewable Energy Systems
j) Available Solutions for Compliance
7) Case Studies
a) Great River Energy Headquarters
b) Genzyme Center
c) Duke University Smart Home

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Maintenance Best Practices for Energy Efficient Facilities
Course Outline
Course Description
Good maintenance saves energy costs! Properly maintained facilities run quietly, produce quality products, reduce downtime and have fewer accidents. This course will address the importance of maintenance can contribute, and identify techniques that can lead to the energy maintenance of facilities.
Course Outline
Course Objectives
• List organizational problems that lead to poor maintenance of an
• List examples of energy efficiency costs caused by inefficient components (e.g. compressed air, steam, etc)
• Calculate the energy costs associated with various types of maintenance failure
• Identify simple ways that infrared, vibration analysis, and ultrasonic surveys identifying maintenance needs
Course Content or Material
1) Introduction
2) Organizational problems
i) Common maintenance problem areas
(1) Lack of work order system
(2) Poor reporting of work orders
(3) Poor analysis of work orders – (Pareto analysis)
(4) Inadequate preventative maintenance program

(5) Inadequate maintenance training
(6) Poor control of maintenance efforts
(7) Lack of management attention
3) Characteristics of an effective
maintenance
i) Bring discipline to the maintenance
process by ensuring
• Definition of responsibilities
• Adequate training
• Sufficient tools and equipment
• Clear procedures, including evaluation
of results, and an emphasis on identifying
reinforcing best practices
ii) These systems can be simple, manual
inputs from sensors such as differential
pressure across filters, equipment
temperatures and vibration
iii) In either case, there are basic
requirements for work order system
analysis, generation of maintenance
orders, and performance records of
4) Examples of energy efficiency costs
i) Steam leaks
ii) Steam trap failures
iii) Compressed air leaks
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iv) Uninsulated pipes
5) Tables and charts – Calculating the cost
6) Steam Systems
The steam system maintenance should
include:
Steam Trap Survey and Repair
Leak Repair
Insulation Repair
7) Compressed Air Systems
i) An efficient compressed Air System
must include a regularly scheduled
survey for air leaks.
8) Lighting
.
Once your solution is defined, your
maintenance program should cover:
(a) Cleaning
(b) Relamping
(c) Monitoring compliance with
expectations
(d) Maintaining standard IESNA light levels
9) Motors
a) Use Premium Energy Efficient motors
where possible particularly for
failed motors
b) Use Variable Speed or Variable
Frequency drives
c) Use cogged belts or synchronous belts
i) Properly align motors and drives
(1) Use laser alignment tools for both
direct drive and belt drives
(a) This step is crucial to extend motor life.
(i) Design motor bases for easy
adjustment

10) Ultrasonic, Infrared and Vibration

In the last section of this class, let's look

can be usefully applied to the energy and

efficiency maintenance of the systems we

discussing

a) Ultrasonic Leak detectors

i) Air leaks

(1) Survey for air leaks during full

production periods

ii) Steam Traps

(1) Survey steam traps during winter

h) Specialty gas leaks – especially for high

cost gases – Nitrogen, Argon, Carbon

Dioxide

iv) Vacuum system leaks

v) Duct work Leakage– particularly

in lab and pharmaceutical facilities –

vi) can be used in some pharmaceutical leak

testing processes

b) Infrared

i) Infrared inspection equipment is widely

available and is astonishing cheap

ii) Electrical gear inspection

iii) Insulation hot spots

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iv) Roof inspections - Aerial infrared

roof inspection especially when trying to

points / saturated insulation

v) Boiler Lagging / Flue Gas Leaks

(1) Infrared inspection can determine

point where the leak starts

c) Vibration Analysis

i) Motors and Bearings

(1) Motor / Drive bases should have a

concrete. Concrete is a cheap method of

adding mass

ii) Fans

(1) Always dynamically balance fans in

balancer at the factory. It is common for

fans to become damaged and or out of

balance during shipment or installation.

iii) Production machinery

(1) Vibration problems usually have one

of three causes: Imbalance, misalignment,

or looseness. Any of these methods can

iv) Vibration problems once resolved

in large rotating machinery. Often

include vibration sensors for continuous

monitoring

Course Assessment: Test Your Knowledge

Course Survey: We Value Your

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Steam Systems I: Advantages and Basics

of Steam

Course description:

Steam has come a long way from its

revolution. Today, it serves as an integral

introduce the benefits of utilizing steam

in numerous processes and discuss t

pressures for each of these different processes

Course Outline:

Learning objectives

At the completion of this course you will be able to:

- List the advantages of steam
- Describe the formation of steam
- Understand the relationship between pressure, temperature, and energy

Course content or material

1) Introduction

a. Advantages of steam

b. What is steam

c. Definitions

i. Joules

ii. BTUs

iii. Temperature

iv. Saturation

v. Enthalpy

vi. Absolute pressure

vii. Gauge pressure

viii. Differential pressure

ix. Sensible heat

x. Latent heat

xi. Total heat

2) Formation of Steam

a. How steam is created

b. Heat energy transfer

i. Example

c. How a boiler makes steam

3) Relationship between pressure, tem

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Waste Heat Recovery

Course Description: Waste heat is

opportunities exist to put this waste heat

energy consumption in the plant. How the

recover waste heat, and the equipment

capturing waste heat recovery will also

influence the feasibility of waste heat

recovery.

Learning Objectives:

At the completion of this course, you will

- List the factors that influence the feasibility opportunities to recover waste heat, the temperature ranges of heat recovered and the possible uses
- Perform calculations of waste heat
- Categorize and explain the general operation of the main equipment used to recover waste heat

Course Content or Material

1) Introduction

2) Benefits of Waste Heat Recovery
a) Direct benefits
i) Reduced energy consumption
ii) Consequent increase in energy efficiency
b) Indirect benefits
i) Reduction in pollution
ii) Reduction in equipment size
iii) Reduction in auxiliary energy consumption
3) Factors Influencing Waste Heat Recovery Feasibility
a) Sufficient quantity
b) Sufficient quality
c) Used economically
d) Location
e) Availability
f) Compatibility
g) Concerns
h) Limits on heat recovery
4) Waste Heat
a) Quality
i) Dependent upon the temperature of heat available
ii) Economic recovery would depend upon following factors:
b) Quantity Of Waste Heat
i) Quantity of heat (in kcal) = V x ρ x Cp x Δt
c) Typical Sources Of Waste Heat
i) Heat in waste gases from industrial processes (high temperature)
ii) Combustion flue gas (medium temperature)
iii) Low temperature heat recovery
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iv) Other sources of waste heat
d) Uses of Waste Heat
i) Waste heat can be put to use depending upon the type of plant and on heat available particularly with relation to temperature and quantity
ii) Pre heating of combustion air:
iii) Pre heating of boiler feed water:
iv) Vapour Absorption Refrigeration:
v) Pre heating for process requirements:
5) Development Of Waste Heat Recovery System
a) Compatibility of waste heat quality:
b) Scheduling:
c) Location
6) Waste Heat Recovery Devices
a) Recuperators
b) Economizers
c) Waste heat boilers
d) Heat pumps
e) Regenerators

f) Heat Wheels

g) Heat Pipes

h) Other Waste Heat Recovery Devices

7) Sources and Utilization of Waste Heat Summary Chart

8) Matrix of Waste Heat Recovery Devices/Applications

9) Calculating Waste Heat Recovery

a) Overview

b) Case Study Examples

10) Summary

Course Assessment: Test Your Knowledge

Course Survey: We Value Your Opinionperature, and energy

4) Summary

d) Schneider Electric and LEEDs

8) Summary

4) Summary

7) Summary

Analyzing Reliability in the Data Center
Outline

Course Description:

The growing reliance on information systems that operate 24 hours per day, 7 days per week, has

spawned a rapidly growing and developing industry that supplies products and services on

demand. The need for these types of information services now reaches into every business office

in the world. Unfortunately, events of all kinds including hardware failure, human error,

environmental changes, structural failure and external events, can lead to the possibility of

unanticipated systems downtime.

Modern data centers do not tolerate planned downtime and strive for no outages in a 10-year

mission. Data center operations staffs are faced with the dilemma of either downtime as a result of

insufficient physical infrastructure, or incurring extensive costs by designing in more redundancies

than is necessary. Targeted reliability solutions allow businesses to meet individual requirements of

the data center, while minimizing the total cost of ownership.

In fact, very high reliability is difficult to attain and redundant hardware is only part of the answer.

This course will demonstrate some important performance success factors and overviews best

practices for analyzing and optimizing reliability.

Course Outline:

Learning Objectives

At the completion of this course, you will be able to:

§ Define key terms associated with analyzing reliability risks

§ Identify some common cause failures in the data center

§ Describe the benefits of conducting a Probabilistic Risk Assessment (PRA)

§ Recognize the reliability advantages of utilizing scalable, modular architecture in the data center

Agenda

§ Introduction

§ Analyzing risk

§ Redundancy

§ Common cause failures

§ Probabilistic Risk Assessment (PRA)

§ Case study example

§ Summary

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1) Introduction

a) Information systems need to operate 24 / 7

b) Growing and developing industry supplies products and services on-demand

c) Modern data centers do not tolerate planned downtime and strive for no outages in a 10-

year mission

d) Data center operations staffs are faced with

e) The dilemma of downtime as a result of insufficient physical infrastructure

f) Incurring extensive costs by factoring in unnecessary redundancies

| | |
|---|---|
| | g) Targeted reliability solutions allow businesses to meet individual requirements of the data |
| | center, while minimizing the total cost of ownership |
| | 2) Reliability |
| | a) Understanding how to best define downtime risk |
| | i) Is important to optimizing its reliability |

ii) Decreases total cost of ownership

iii) Increases agility

b) Reliability metrics statistically analyze
the likelihood of a failure occurring

3) Redundancy

a) While redundancy can increase
reliability, there are significant costs and
potentially

serious drawbacks

b) A redundant system has more components

c) In general, systems with more components will experience more failures

4) Discussing Best Practices

a) The design, manufacture, operation, maintenance and repair of equipment

b) The gathering of data, and the review and publication of component benchmarking results

c) Consistent deployment of the language of reliability, both definitions and assumptions

d) A philosophy addressing the constant pursuit of root causes, common cause failures and

relevant data

5) Modularity and Component Count

a) Reliability can be increased through standardization

b) Modularity is a powerful concept

c) Modularizing a system can increase the number of internal components

d) Reliability analysis of modular systems must consider

i) Component design

ii) Function

iii) Dependencies

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a) Data center testing and maintenance practices often have a significant impact on systems

reliability

b) Testing and diagnosis can improve reliability, but may also degrade it

7) UPS: Historical Perspective

a) In most UPSs, utility AC power is rectified to DC

b) The inverter synthesizes an AC voltage free from the effects of spikes, sags, harmonics,

and brief utility outages

8) Assessing Reliability

a) Product support engineers

i) Track the products' performance in actual use

ii) Identify and implement changes necessary to correct deficiencies or defects

iii) Benefit from a road map identifying components most likely to fail

b) Deviations from the predictions of the road map would identify new areas for more

intensive investigation and possible remedial action

9) The Correct Course of Action: PRA

a) The process of building the logical model results in a comprehensive review

b) The mathematical nature of the calculation limits the logical fallacies that tend to dominate

qualitative evaluation of reliability

c) The implication is that if N components are required for success, there is one, two, twice

as many, or even twice plus one as many units available

d) Not all redundancy makes the same contribution to reliability

10) Reliability Assessment Case Study

a) The mathematical models that resulted from the analysis were used to answer some key questions

b) The scalable, modular system utilizes redundancy in nearly all components as a means of achieving high reliability

c) MTechnology, Inc's analysis showed that

d) There are both costs and benefits to redundancy

e) Some sub-systems benefit less from redundancy than others

f) Complex mathematical formulas were utilized to calculate the case study failure rates and

common cause failures

11) Case study goals

a) To identify potential sources of failure

©2013 Schneider Electric. All rights reserved. All trademarks provided are the property of their respective owners.b) To evaluate the potential for further improvement in the scalable, modular power system’s

reliability and availability

12) Target of Case Study Analysis

a) Subjects of analysis

| |
|---|
| i) 14 - 40 kW Scalable, modular, rack based power system with PDU and static bypass |
| |
| ii) 500 kW central UPS |
| |
| b) Tools utilized |
| |
| i) Probabilistic Risk Assessment (PRA) |
| |
| ii) Fault tree |
| |
| iii) Event tree analysis |
| |
| iv) Bayesian updating |
| |

13) Reliability Assessment Case Study

a) All actions have both beneficial and negative affects on reliability

b) It helps to support the uptime of the servers but also can represent a point of failure

14) Comparing Modularity to the Central UPS

a) The scalable, modular system loses power to all loads only when

i) The main entrance bus fails

ii) The transfer switch fails to open

b) The probability of all 14 scalable, modular units failing simultaneously due to internal

failures is extremely low

c) PDU failure will cause partial load drop

d) Only one circuit breaker after the transfer switch will cause all critical loads to fail

15) Central UPS data

a) Battery failure is a significant contributor of failure in central UPS

b) The central UPS can fail internally, and bypass can fail, causing all loads to fail

c) PDU failure will cause partial load drop

16) Reliability Assessment Case Study: The Findings

a) The calculated reliability of the scalable, modular power system is comparable to data

published by vendors of large, central UPSs

b) The scalable, modular power system is significantly less likely to suffer a complete system

failure

c) The redundancy provided in the scalable, modular power system definitely improves the

product's reliability

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a) Overall, the scalable, modular architecture had a system failure rate was approximately

40% lower than that of the central UPS system

b) Failure is defined as the loss of power for all critical loads

c) Discounting battery failures, the scalable, modular failure rate is still approximately 18%

less than that of a comparable central UPS architecture

d) If failure is defined to include dropping of any single load due to a branch circuit failure, but

not UPS failure, the scalable, modular architecture is 6% less likely to fail

e) Scalable, modular power system architecture proved more reliable than the single module

| |
|---|
| UPS with a single battery string |
| |
| f) The redundant subsystems within the scalable, modular power system successfully reduced the probability of UPS failure |
| |
| g) The performance of the ATS is often the limiting factor in achieving higher reliability |
| |
| 18) Summary |
| |

a) Understanding how to best define downtime risk is important to optimizing its reliability,

while decreasing TCO and increasing agility

b) While redundancy can in principle increase reliability, there are significant costs and

potentially serious drawbacks

c) Data center professionals need to understand which processes are most critical, and

target reliability accordingly

d) PRA is a powerful tool when applied carefully

Course Assessment: Test Your Knowledge

Course Feedback: We Value Your Opinion

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An Introduction to Medical Gas and Vacuum Systems

Course Outline

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Course Outline

Course Description

This course introduces plumbing and discuss the various types of medical gas their purpose of these systems is to care provide safe and reliable support to the

Codes and standards are also discussed.

Course Objectives

- Discuss the purpose of plumbing and medical gas systems
- Identify the various types of medical gas and vacuum systems used in health
- Review the important codes and standards used for medical gas and

Course Content or Material

1. Introduction

a. Introduction to Medical Gas and Vacuum Systems

2. Types of medical gas and vacuum systems

a. Medical gas systems

i. Oxygen

ii. Medical Air

iii. Nitrous Oxide

iv. Nitrogen

v. Carbon Dioxide
vi. Mixed Gases
vii. Instrument air
b. Vacuum Systems
c. Medical/Surgical Vacuum
d. Waste Anesthetic Gas Disposal
e. Dental Vacuum Systems (Tim will write
script)
3. Codes, standards, regulations and
authorities having jurisdiction
a. NFPA 99
b. FGI Guidelines
c. Local or state regulations
d. Enforcement
i. Certificate of occupancy
ii. CMS and accreditation
e. ASSE Standards
4. Categories of medical gas and vacuum
systems
a. Introduction to NFPA 99 Categories
b. Category 1
An Introduction to Medical Gas and
Vacuum Systems
Course Outline
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c. Category 2
d. Category 3
Course Assessment: Test Your Knowledge

Course Survey: We Value Your Opinion

On Mon, Mar 17, 2025 at 10:39 AM
tshingombe fiston
<tshingombefiston@gmail.com> wrote:

We will be conducting system maintenance Sunday March 16, 2025 9:00 p.m.-11:00 p.m. EDT. Please note that you will not be able to login at this time.

Course Assessment - Results page

1

2

3

4

5

6

7

8

9

10

Question

A/n _____ measures the amount of electrical current flowing through a circuit during a specific time interval.

Ampere

Volt

Ohm

Watt

Question

Materials with _____ resistance require more voltage to make the electricity flow.

Lower

Higher

Slower

Faster

Question

True or false? The electrical load in a data center is the sum of the various pieces of data center equipment which consume and are supplied with electrical power

T

F

Question

The power in Watts is the _____ power drawn by the equipment, while Volt-Amps is called the _____ power.

Electrical, real

Apparent, real

Real, apparent

Real, solar

Question

A circuit breaker may need to switch short circuit currents as high as _____ times its rated current.

30

15

10

5

Question

Circuit breakers can fail in which of the following ways:

Failure to close, or failure to open under fault conditions

Spurious trip

Failure to operate with the time-current specifications for the unit

All of the above

Question

This form of standby power uses electromagnetism to produce electricity

a, Electrochemical generator

Battery

Fuel cell

Mechanical generator

Question

_____ occur when there is a varying quality of connections to the earth at different points in an electrical installation

Ground loops

Power factor corrected power supplies

Ground Fault Circuit Interrupters

Thermal-magnetic circuit breakers

Question

An approach to solve the problem of impulsive transients includes the utilization of which device?

Power Line Conditioners

| |
|---|
| Uninterruptible Power Supply (UPS) |
| |
| Voltage Surge Suppressor (TVSS) |
| |
| Modern harmonic-correction equipment |
| |
| Question |
| |

According to M Technology, Inc., what percentage of the time are circuit breakers involved in a power system failure in data center electrical infrastructure?

10%

40%

70%

50%

Course Assessment - Test

Course Assessment

Number of questions:

10

Questions are shown:

One by one

So far you have done this test 1 time

Previous unit: Online Course

1.4% completed

Lesson Fundamentals of Power

Course Overview - Passed

Online Course

Course Assessment - Current unit

Reference Materials

Course Transcript

Lesson Going Green: Energy Efficiency in the Data Center

Course Overview

Online Course

Course Assessment

Course Feedback

Reference Materials

Course Transcript

Lesson Building Controls I:
An Introduction to Building Controls

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Combined Heat and Power

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Compressed Air Systems I: An Introduction

Course Overview

Online Course

Course Assessment

Course Feedback

Reference Materials

Course Transcript

Lesson Energy Efficiency with Building Automation Systems

I

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Procurement I: Options in Regulated and Deregulated Markets

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Procurement II: Introduction to Hedging in Deregulated Markets

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Procurement
III: Balanced Hedging
Strategies

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Energy Rate
Structures I: Concepts and
Unit Pricing

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Going Green with Leadership in Energy and Environmental Design

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Maintenance Best Practices for Energy Efficient Facilities

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Steam Systems I: Advantages and Basics of Steam

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Lesson Waste Heat Recovery

Course Overview

Online Course

Course Assessment

Reference Materials

Course Transcript

Previous unit: Online Course

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10) Calculating Efficiency and Operating Cost

a) The technical design of the modular, scalable system results in a much higher rate running on lightly loaded UPS units

b) The Fortune 500 firm in our case study:

i) Chooses to implement redundant UPS systems and operates each of them at

capacity
ii) Chooses the "install as you grow
differences in energy savings, and
therefore, lower electrical bills
17) Total Cost of Ownership
a) Capital costs
i) Allow for an initial build out of 27 watts
ii) Assume a build out to 80 watts per
square foot for an additional 5 years
b) Electrical costs
i) Load levels will be at 80% of 2 (N+1)
ii) The maximum loading on any one
system is 40%
c) Service costs
i) Customer requires 7x24
ii) 4 hour response
iii) 100% coverage on parts and labor
iv) Battery maintenance will not be
included
18) Key TCO Components of Payback
19) Summary
a) The green data center features a safe
and healthy work environment and
energy efficient manner
b) Five examples of green approaches in
the data center include the cooling use of
cross, ngnuzed solutions, cooling
c) TCO analyses can justify investments in
green technologies

Course Assessment: Test Your Knowledge

Course Feedback: We Valu

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Fundamentals of Power Outline

Course Description

Power is the foundational cornerstone in
downtime, software and data corruption,
imperative that servers are insulated
electrical problems. This course will
explore the topic of power, and how it is
center.

Course Outline:

Learning Objectives

• Identify basic electricity concepts

• Describe electrical power and its conversion
• Differentiate between various power usages in a data center
• Define power factor
• Recognize the importance of electrical safety in power distribution
• Identify potential problem areas in the data center

Agenda

• Electrical power key terms
• AC and DC power
• Power factor
• Volt configurations, plugs and receptacles
• Circuit breakers and convenience outlets
• Seven common electrical problems
• Components in a data center

Introduction

1) Key Terms

a) Volt (V)
b) Ampere (Amp)
c) Ohm (Ω)
d) Hertz (Hz)
e) Alternating Current (AC)
f) Direct Current (DC)
g) Load

2) Single-phase and 3-phase Power

3) Watts and Volt-Amps

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4) Power Factor Correction

a) Power factor of nearly 1
b) Method of offsetting inefficiencies created by electrical loads

5) Plugs and Receptacles

a) The most common plug/receptacle combination for IT equipment is of an IEC
b) Also common are plugs and connectors of the twist-lock variety
c) International Electro-technical Commission Plugs
d) National Electric Manufacturers Association Plugs

8) Circuit Breakers

a) A type of switch
b) Designed to protect electrical equipment from damage caused by
c) Designed to trip at a given current level

9) Circuit Breaker Protection

10) Circuit Breaker Sizing

11) GFCI, ELCB, and RCD

a) Ground Fault Circuit Interrupters (GFCI), Earth Leakage Circuit Breakers or Residual-current devices (RCD) trip a circuit if they detect a small amount of current
b) Larger data centers use resistor banks instead of GFCI, ELCB, or RCD

12) Convenience Outlets

a) Used for non-computer devices

b) Allows for other non-computer equipment to be plugged in without
13) Grounding
a) Safety measure to protect against electric shock
14) 7 Power Problems
a) Impulsive Transients
b) Interruptions
c) Sags and Undervoltages
d) Swells and Overvoltages
e) Waveform Distortion
f) Voltage Fluctuations
g) Power Frequency Variation
15) Standby Power and Distribution
©2021 Schneider Electric. All rights reserved. All trademarks provided per the
a) Any power source available to the data center that supplies power when utility unavailable
16) Power Distribution Components
a) Primary power source (Utility)
b) Emergency power source (Generator)
c) Circuit/Branch Circuit
d) Uninterruptible Power Supply (UPS)
e) Automatic Transfer Switch
f) Power Distribution Units (PDU)
g) Outlet Strips
h) Server Plug
17) Summary
a) Power infrastructure is critical to
b) Understanding basic power terms
battery, standby power equipment, and
c) Failures can occur at various points in
given to the construction and commissioning
d) Numerous power anomalies exist that
e) Understanding the threats and ways
applying practical power solutions can
Course Assessment: Test Your Knowledge
Course Feedback: We Value Your
Opinion©2021 Schneider Electric. All rights
i. The controlling variable is affected by the actions of the controlled device upon the controlled variable
c. Cascading
i. Used to modify the performance of closed control loops when required
5) Red Wire & Direct Digital Controls
a. DDC
i. More sophisticated system
ii. Use electronic controllers that support multiple control loops
b. Enable / disable control
i. Another form of electronic control
ii. Simply turns another controller on or off

iii. One controller will determine when another controller is able to perform its function

6) Summary

a. For an environmental control system to effectively maintain a building, thereby occupant comfort, three things must take

i. Data must be measured and provided

ii. Measured data then can be compared to a set of desired outcomes or instructions

iii. An output is produced based on the measured data to change or maintain the environment

b. A simple control loop is defined as one control logic, which provides an output to

c. Inputs and outputs may be analog or digital

d. A controller may contain many control loops, and a control system may contain many controllers

e. There are three types of control loops

i. Open

ii. Closed

iii. Cascading

f. And there are three common control technologies

i. Pneumatic

ii. Electrical, and

iii. Electronic

g. Electronic controls may be

i. Direct Digital Control, called DDC, or

ii. Enable / Disable Control

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Combined Heat and Power (Cogeneration)

Course Description: Cogeneration today

production of heat and power

a single thermodynamic process. The

to applying technologies to the function

and construction of deployment of the

cycle plants including combined

Prerequisites for this course include:

Energy Rate Structures Level II

Learning Objectives:

At the completion of this course, you will

• Define what cogeneration is along with

• Identify the different approaches for

• Discuss the various factors to consider

when evaluating the use of a CHP plant

Course Content or Material

1) Introduction

a) Technology overview

b) Defining “cogeneration”

i) How cogeneration occurs

ii) Primary fuels used

2) Two main approaches for cogeneration
a) Topping cycle plants (including Combined Cycle plants)
i) Examples
ii) Overview
b) Bottoming Cycle Plants
i) Examples
ii) Overview
3) Environmental Issues
a) Benefits
b) Concerns
4) Things to Consider When Applying CHP Plant
a) Steam load versus electric load
b) Capital utilization / productivity
c) Reliability requirements (steam and electric)
d) Local electricity rates
e) Efficiency gains versus fuel prices
f) Fuel availability and selection
g) Staffing and training
5) Comparing CHP Technologies
a) Diesel engine
b) Natural gas engine
c) Steam Turbine
d) Gas Turbine©2023 Schneider Electric. All rights reserved. All trademarks
Compressed Air Systems I: An Introduction
Course Description
Compressed air is widely used throughout industry, right alongside electricity, gas and water. From mining, production to small manufacturing plants and represent the majority of the facility's compressed air, reliability is paramount, but consumption by 20% to 30%, energy is lost. This is the first in a series of compressed we will introduce the relative inefficiency of compressed air and examine the air system.
Course Outline
Course Objectives
Objectives
• Explain basic compressed air terms and
• Describe the relative inefficiency of
• Define the supply and demand sides of
• Identify the components of a compressed air system and explain what
Course Content or Material
1) Introduction
2) Supply & Demand
a. Divided into a supply side and a demand side
3) Compressed Air Pros & Cons

4) Compressed Air Inefficiency Examples
a. Metric Unit Example
b. US Customary Unit Example
5) Compressed Air Systems Optimization
a. The efficiency of compressed air
systems is directly related to operation
i. Systems are not well understood by
ii. Improving a system is perceived as a
risk to production
iii. Vendors compete in a market where
price, without regard for the cost of
operation
b. Optimization leads to
i. Reduced costs
ii. Reduced maintenance
iii. Less downtime
iv. Increased production
v. Improved product quality
6) Equipment Descriptions
a. Fan
b. Blower
c. Compressor
7) Pressure Terminology
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a. Pressure
b. Absolute Pressure
c. Gauge Pressure
8) Standard Volume of Air
a. Metric
b. US Customary
9) Volume Flow
a. Inlet flow
b. Actual flow
c. FAD
d. Standard flow
e. Capacity
10) Operating cost
a. Proportional to volume
b. Proportional to pressure ratio
11) Dew Point
a. The temperature at which
condensation begins to occur
12) Compressed Air Requirements
a. Cleanliness
b. Dryness
c. Oil content
13) Compressed Air System Components
a. Interactive element
14) Summary
a. Basic compressed air terms and
concepts:

b. Compressed air as a source of power is relatively inefficient. However, it can be useful and necessary at times;
c. Compressed air systems are normally broken down into supply and demand components;
d. You should now be able to identify basic components of a BAS and explain what they do

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Energy Efficiency with Building Automation Systems Part 1

Course description:

In this course we will focus on what a building automation system (BAS) is and its commonly used terminology. We will also look at some of the HVAC strategies used in automation systems.

Course Outline:

Learning objectives

At the completion of this course you will be able to:

- Define what a building automation system is
- Review the main terminology and components of a Building Automation System
- List the most common HVAC strategies that may be controlled by a Building Automation System

Course content or material

1) Introduction
a. What is building automation
b. What are the functions of building automation systems (BAS)
2) Parts of a BAS
3) Terminology
a. Set point
b. Air
4) Review of HVAC systems
a. Equipment
i. Air handling unit
ii. Chiller
iii. Cooling tower
iv. Flow controller
v. Boiler
vi. Dual duct
vii. Constant volume/variable temperature
viii. Variable air volume
ix. Terminal reheat

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Energy Procurement I

Course Description: The procurement of becoming a major part of the energy understanding of the market, regulatory The purpose of this course is to raise awareness of the available options for

Learning Objectives:

- Define the roles of the main players in the energy chain
- Explain the major differences in regulated and deregulated markets

- List the main options available for optimizing energy procurement

Course Content or Material:

1) Introduction

2) Types of Energy Typically Procured

a) Most common electricity and natural

b) Coal, Oil-based fuels, Steam, Compressed air

3) Energy Supply Chain

a) Production, Transmission, Distribution, Supply

b) Gas supply chain

c) Electricity supply chain

4) Regulated and deregulated markets

a) Regulated Markets

b) De-regulated Markets

c) Wholesale versus Retail

d) Equal access to transmission and distribution

e) Drivers of Deregulation

f) Pricing

i) in a regulated market

ii) in a deregulated market

g) Options in a regulated market

i) Natural gas contracts

ii) Power contracts

h) Options in a deregulated market

i) Supplier Options

i) Local distributor

ii) Gas or power marketers

iii) Brokers

iv) LDC Marketing Departments

v) Aggregator

vi) Power Pool and Exchange Operators

vii) Overview of Supplier Options

viii) Pipeline Connects for Large Consumers

5) Procurement pitfalls

a) Exposure to energy price volatility that

b) Energy that is managed locally with no

c) Procurement decisions that are made by personnel without knowledge of the market

d) Contracts renewed based on

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e) Contract renewals that embedding the

f) A conviction that hedging is speculative

g) Deregulation Growing and Prices are Volatile

a) Hedging

b) Avoiding pitfalls of lowest price and highest risk

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Energy Procurement II

Course Description: Unprecedented volatility in today's energy markets has

havoc on the profit margins and bottom
successfully manage costs in this market,
purchasing strategies—or as it is based
price risk management and hedging
mitigate the impact of these events on
management program can provide risk
earnings from the unpredictable effects
course is to address the hedging process.
Markets as well as fixed and indexed
Prerequisites: Energy Procurement I:
Options in Regulated and Deregulated

Learning Objectives:

At the completion of this course, you will
• Explain the difference between spot
• Describe how hedging reduces your
• Define the meaning of fixed and index-
linked contracts

Course Content or Material

1) Introduction

a) Brief overview of gas and electricity
markets

b) Energy procurement

2) Procurement Pitfalls

a) Common pitfalls in a deregulated
market

b) How energy managers remedy
common errors in energy procurement

3) Commodity Markets for Energy

a) Commodity exchanges

i. The New York Mercantile Exchange
(NYMEX)

ii. The Singapore Commodity Exchange
(SICOM)

iii. The former International Petroleum
Exchange (IPE), bought and now part of Intercontinental Exchange
(ICE)

iv. Over The Counter

b) Energy buyer options

i. Spot market

ii. Forward market

i. Fixed contract

ii. Index-linked contract

4) Determining Energy Prices

a) Total energy costs

b) Regulated cost components

c) Commodity-based market purchasing

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5) Avoiding Pitfalls of Lowest Price and
Highest Risk

a) Define energy purchasing strategy

i) Spot purchasing versus fixed price
purchasing

ii) Hedging

6) Implementing Hedging

a) Forward contracts

b) Futures market

c) Flattening a position
d) Trading forward contracts
e) Permutations
f) Contract expiration
g) Imbalances upon delivery
7) Hedging Examples
a) Hedging on the forward market
b) Settling contracts on the spot market
8) Fundamental Concept of Hedging
a) Shaves off the extremes
b) Provides predictability
9) Adopting a Balanced Approach to Hedging
a) Full requirements fixed-price
b) Partial fixed-price
c) Partial spot market
d) Staggered fixed-price

energy procurement in balanced electric

Course Description: Managing energy and volatility are many industri
cts market, it is important to apply a
approach with quantity exposure to and
events on financial results. The purpose
strategies, and identify the main drivers
commodity market functions to support

Pre-requisites: Energy Procurement I and Energy Procurement II

Learning Objectives:

At the completion of this course, you will be able to:

- Describe a variety of balanced hedging strategies
- List the main drivers of energy price
- Describe how commodity markets function to support energy trading

Course Content or Material

1) Adopt a Balanced Hedging Strategy
a) Brief overview of concepts covered in Energy Procurement II
i) Full requirements fixed-price
ii) Partial fixed-price
iii) Partial spot market
iv) Staggered fixed-price commitments
b) Determination requirements
i) Commitment term
ii) Tolerable price levels
iii) Range of tolerable cost fluctuation and
iv) Minimum/maximum time horizons for
v) Plan of action to mitigate damage for when prices change rapidly
2) Risk Tolerance
a) Definition of hedge ratio
b) Defining risk tolerance

3) Defining a Hedge Ratio and Strategy
a) Riverbanks analogy
b) Examples of hedge ratio and energy purchasing strategies
4) Exchange Operation
a) How commodity exchanges function
b) Commodity exchange regulation
c) Commodity-based market purchasing strategies
5) Terms and Mechanisms
a) The short position – which means you are agreeing to sell
b) The long position – which means you are agreeing to buy
c) The price of the contract
d) The daily account adjustment
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e) The final settle price
f) The strip
g) Futures market versus the stock market
h) Final settle
6) Drivers of Energy Prices
a) Supply
b) Demand
c) Seasonality
d) News and Rumors
e) Speculators
7) Commodity Risk Analysis
a) Role of gas and power marketers
b) Role of independent market analysis service providers
8) The Forward Curve
a) Definition
b) Examples
9) Price Forcasting
a) Definition
b) Examples
10) Other Procurement Considerations
a) Price, dependability and service
b) Importance of considering
11) Best Practices
a) Integrates on a continual basis
i) Data
ii) Risk management
iii) Procurement
b) Employs
i) Data driven decisions
ii) Management approach that identifies and quantifies risk before determining the best way to manage it
iii) Procurement optimisation with operations

12) Summary

10) Summary

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Energy Rate Structures Part 1: Concepts and Unit Pricing

Course description:

Understanding the forms of energy used is key to understanding energy costs and understanding what you are paying for, you can adopt different strategies for and be able to move to a different rate structure we will focus primarily on gas and electricity concepts and unit pricing. In this

Course Outline:

Learning objectives

At the completion of this course you will be able to:

- Define and recognize the difference between different forms of energy
- Flat rates, block rates, seasonal pricing, time of use rates, and real time pricing

Course content or material

1) Introduction

a. Understanding different forms of energy

2) Consumption and Demand

a. Difference between consumption and demand

b. Example

3) Energy Pricing

a. Types of energy pricing

i. Flat rate

ii. Block rate

1. Declining

2. Inverted

iii. Seasonal rates

iv. Time-of-Use rates

1. On-peak

2. Off-peak

3. Shoulder/Mid-peak

v. Time of use rates

vi. Real Time Pricing

vii. Other forms of pricing©2023 Schneider Electric. All rights reserved.

Going Green with Leadership in Energy and Environmental

Design Course Outline

Course Description:

This course defines green buildings, building council and the requirements of the Environmental Design (LEED) rating meeting the LEED requirements will also be explained.

Course Outline:

Learning Objectives

At the completion of this course, you will be able to:

• Define the characteristics of Green Building

• Explain the mission of the US Green Building Council

• Identify the Leadership in Energy and Environmental Design (LEED) rating system

• Describe Schneider Electric products and services which satisfy LEED requirements

Agenda

• Introduction

• Impacts of US Buildings on the Environment

• Advantages of building green

• Review the Mission of the US Green Building Council

• Discuss the LEED rating system

• Discuss Schneider Electric products and services that satisfy LEED requirements

• Introduce Case Studies

• Summary

Course Content or Material

1) Introduction

a) Green Building

b) Design of Leadership in Energy and Environmental Design (LEED)

c) Who makes up the LEED team

d) LEED reach

e) Point of the LEED point based system

f) Why is there a demand

2) Impacts of US Buildings on the Environment

a) Impacts of US buildings on resources

b) US Energy Consumption

c) US Electricity Consumption

3) Advantages of Building Green

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a) Demand for Green Building

b) Perceived Business Benefits

c) Predictions in growth of Green

d) Next Generations impact of perceptions of green build

4) Mission of USGBC

a) Mission statement for USGBC

b) What the USGBC does

c) Membership

5) LEED Rating System

a) LEED addresses complete lifecycle of buildings

b) 4 Levels of LEED
c) 6 Credit Categories
d) Steps to LEED Certification
e) A sample checklist
f) Available resources on line
g) Schneider Electric products and services that satisfy LEED requirements
a) Maximizing LEED points
b) Building Automation and Control
c) Critical Power and Cooling
d) Engineering Services
e) Field Services
f) Lighting and Lighting Controls
g) Power monitoring
h) Variable Frequency Drives
i) Renewable Energy Systems
j) Available Solutions for Compliance
7) Case Studies
a) Great River Energy Headquarters
b) Genzyme Center
c) Duke University Smart Home

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Maintenance Best Practices for Energy Efficient Facilities
Course Outline
Course Description
Good maintenance saves energy costs! Properly maintained facilities run quietly, produce quality products, reduce downtime and have fewer accidents. This course will address the importance of maintenance can contribute, and identify techniques that can lead to the energy maintenance of facilities.
Course Outline
Course Objectives
• List organizational problems that lead to poor maintenance of an
• List examples of energy efficiency costs caused by inefficient components (e.g. compressed air, steam, etc)
• Calculate the energy costs associated with various types of maintenance failure
• Identify simple ways that infrared, vibration analysis, and ultrasonic surveys identifying maintenance needs
Course Content or Material
1) Introduction
2) Organizational problems
i) Common maintenance problem areas
(1) Lack of work order system
(2) Poor reporting of work orders
(3) Poor analysis of work orders – (Pareto analysis)
(4) Inadequate preventative maintenance program

(5) Inadequate maintenance training
(6) Poor control of maintenance efforts
(7) Lack of management attention
3) Characteristics of an effective
maintenance
i) Bring discipline to the maintenance
process by ensuring
• Definition of responsibilities
• Adequate training
• Sufficient tools and equipment
• Clear procedures, including evaluation
of results, and an emphasis on identifying
reinforcing best practices
ii) These systems can be simple, manual
inputs from sensors such as differential
pressure across filters, equipment
temperatures and vibration
iii) In either case, there are basic
requirements for work order system
analysis, generation of maintenance
orders, and performance records of
4) Examples of energy efficiency costs
i) Steam leaks
ii) Steam trap failures
iii) Compressed air leaks
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iv) Uninsulated pipes
5) Tables and charts – Calculating the cost
6) Steam Systems
The steam system maintenance should
include:
Steam Trap Survey and Repair
Leak Repair
Insulation Repair
7) Compressed Air Systems
i) An efficient compressed Air System
must include a regularly scheduled
survey for air leaks.
8) Lighting
.
Once your solution is defined, your
maintenance program should cover:
(a) Cleaning
(b) Relamping
(c) Monitoring compliance with
expectations
(d) Maintaining standard IESNA light levels
9) Motors
a) Use Premium Energy Efficient motors
where possible particularly for
failed motors
b) Use Variable Speed or Variable
Frequency drives
c) Use cogged belts or synchronous belts
i) Properly align motors and drives
(1) Use laser alignment tools for both
direct drive and belt drives
(a) This step is crucial to extend motor life.
(i) Design motor bases for easy
adjustment

10) Ultrasonic, Infrared and Vibration

In the last section of this class, let's look

can be usefully applied to the energy and

efficiency maintenance of the systems we

discussing

a) Ultrasonic Leak detectors

i) Air leaks

(1) Survey for air leaks during full

production periods

ii) Steam Traps

(1) Survey steam traps during winter

h) Specialty gas leaks – especially for high

cost gases – Nitrogen, Argon, Carbon

Dioxide

iv) Vacuum system leaks

v) Duct work Leakage– particularly

in lab and pharmaceutical facilities –

vi) can be used in some pharmaceutical leak

testing processes

b) Infrared

i) Infrared inspection equipment is widely

available and is astonishing cheap

ii) Electrical gear inspection

iii) Insulation hot spots

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iv) Roof inspections - Aerial infrared

roof inspection especially when trying to

points / saturated insulation

v) Boiler Lagging / Flue Gas Leaks

(1) Infrared inspection can determine

point where the leak starts

c) Vibration Analysis

i) Motors and Bearings

(1) Motor / Drive bases should have a

concrete. Concrete is a cheap method of

adding mass

ii) Fans

(1) Always dynamically balance fans in

balancer at the factory. It is common for

fans to become damaged and or out of

balance during shipment or installation.

iii) Production machinery

(1) Vibration problems usually have one

of three causes: Imbalance, misalignment,

or looseness. Any of these methods can

iv) Vibration problems once resolved

in large rotating machinery. Often

include vibration sensors for continuous

monitoring

Course Assessment: Test Your Knowledge

Course Survey: We Value Your

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Steam Systems I: Advantages and Basics

of Steam

Course description:

Steam has come a long way from its

revolution. Today, it serves as an integral

introduce the benefits of utilizing steam

in numerous processes and discuss t

pressures for each of these different processes

Course Outline:

Learning objectives

At the completion of this course you will be able to:

- List the advantages of steam
- Describe the formation of steam
- Understand the relationship between pressure, temperature, and energy

Course content or material

1) Introduction

a. Advantages of steam

b. What is steam

c. Definitions

i. Joules

ii. BTUs

iii. Temperature

iv. Saturation

v. Enthalpy

vi. Absolute pressure

vii. Gauge pressure

viii. Differential pressure

ix. Sensible heat

x. Latent heat

xi. Total heat

2) Formation of Steam

a. How steam is created

b. Heat energy transfer

i. Example

c. How a boiler makes steam

3) Relationship between pressure, tem

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Waste Heat Recovery

Course Description: Waste heat is

opportunities exist to put this waste heat

energy consumption in the plant. How the

recover waste heat, and the equipment

capturing waste heat recovery will also

influence the feasibility of waste heat

recovery.

Learning Objectives:

At the completion of this course, you will

- List the factors that influence the feasibility opportunities to recover waste heat, the temperature ranges of heat recovered and the possible uses
- Perform calculations of waste heat
- Categorize and explain the general operation of the main equipment used to recover waste heat

Course Content or Material

1) Introduction

2) Benefits of Waste Heat Recovery
a) Direct benefits
i) Reduced energy consumption
ii) Consequent increase in energy efficiency
b) Indirect benefits
i) Reduction in pollution
ii) Reduction in equipment size
iii) Reduction in auxiliary energy consumption
3) Factors Influencing Waste Heat Recovery Feasibility
a) Sufficient quantity
b) Sufficient quality
c) Used economically
d) Location
e) Availability
f) Compatibility
g) Concerns
h) Limits on heat recovery
4) Waste Heat
a) Quality
i) Dependent upon the temperature of heat available
ii) Economic recovery would depend upon following factors:
b) Quantity Of Waste Heat
i) Quantity of heat (in kcal) = V x ρ x Cp x Δt
c) Typical Sources Of Waste Heat
i) Heat in waste gases from industrial processes (high temperature)
ii) Combustion flue gas (medium temperature)
iii) Low temperature heat recovery
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iv) Other sources of waste heat
d) Uses of Waste Heat
i) Waste heat can be put to use depending upon the type of plant and on heat available particularly with relation to temperature and quantity
ii) Pre heating of combustion air:
iii) Pre heating of boiler feed water:
iv) Vapour Absorption Refrigeration:
v) Pre heating for process requirements:
5) Development Of Waste Heat Recovery System
a) Compatibility of waste heat quality:
b) Scheduling:
c) Location
6) Waste Heat Recovery Devices
a) Recuperators
b) Economizers
c) Waste heat boilers
d) Heat pumps
e) Regenerators

f) Heat Wheels

g) Heat Pipes

h) Other Waste Heat Recovery Devices

7) Sources and Utilization of Waste Heat Summary Chart

8) Matrix of Waste Heat Recovery Devices/Applications

9) Calculating Waste Heat Recovery

a) Overview

b) Case Study Examples

10) Summary

Course Assessment: Test Your Knowledge

Course Survey: We Value Your Opinionperature, and energy

4) Summary

d) Schneider Electric and LEEDs

8) Summary

4) Summary

7) Summary

TRAINING TRANSCRIPT FOR
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3/10/2024 to 3/10/2025

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**E-mail:**

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| e-Learning Course: Microgrid Modeling and Analysis | |
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e-Learning Course: Sales Training Exam:

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e-Learning Course: Sales Training Exam:

How to Sell More Cables and Connectivity

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e-Learning Course: Surge Solutions

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Transcript

Records may take up to 24 hours to update.

Transcript

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Modules completed

924

Training hours completed

738 hr 43 min

Modules completed

N/A in the module assessment result column means either the module assessment doesn't exist or there's no pass record for it. All modules in this table are complete.

| Module title | Description |
| --- | --- |
| Introduction to Azure Load Balancer | This module explains |
| Enhance your service availability and data locality by using Azure Traffic Manager | Discover how Azure Traffic |

Improve your reliability with modern operations practices: An introduction

Discover a map for navigating reliability challenges and sustainably achieving the appropriate level of reliability in your systems, services, and products.

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The Internet Archive Team (Internet Archive)
<support@archivesupport.zendesk.com>

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**The Internet Archive Team** (Internet Archive)

Oct 19, 2024, 23:07 PDT

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| | It's dispiriting to see that even after being made aware of the breach 2 weeks ago, IA has still not done the due diligence of rotating many of the API keys that were exposed in their gitlab secrets. | | |
| | As demonstrated by this message, this includes a Zendesk token with perms to access 800K+ support tickets sent to info@archive.org since 2018. | | |

Whether you were trying to ask a general question, or requesting the removal of your site from the Wayback Machine—your data is now in the hands of some random guy. If not me, it'd be someone else.

Here's hoping that they'll get their shit together now.

TSHINGOMBEKB TSHITADI

Oct 15, 2024, 09:19 PDT

On Fri, 12 Jul 2024, 20:34 tshingombe fiston, <tshingombefiston@gmail.com> wrote:

Good morning

On Fri, 12 Jul 2024, 14:47 tshingombe fiston, <tshingombefiston@gmail.com> wrote:

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Content Training Installed Base Programs

Overview Support Support Cases Detail

Case #115107868

Open

Created date: 17 Mar 2025, 13:38

Contact: Tshingombe fiston

Sales order number: 2

Account: Tshingombe engineering
(Pretoria, ZA)

Resolving agent: Assignment in progress

Request subject: engineering

Request details: hello

Conversation feed

24 Attachments and 2 Comments

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On Mon, Mar 17, 2025 at 12:44 PM
tshingombe fiston
<tshingombefiston@gmail.com> wrote:

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Content Training Installed Base Programs

Overview All Projects Project details

Project-22 Untitled

open

Created: 9/3/2025 Last Modified: 9/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

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| Add products to Bill of Materials | |
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| By product reference number # | |
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| By Excel/CSV file ( Download sample template ) | |
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| By product segments / selection tools | |
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| Programmable controllers and I/Os | |
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| PLC, PAC, IOs and Power supplies | |
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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Interface, Safety and Control Relays | |
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| Electromechanical, Control, Timing and Solid State Relays | |
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| Enclosures and Accessories | |
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| Enclosures, thermal management, accessories and cabling | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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| Motion Control and Robotics | |
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| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
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| Power Control and Protection | |
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| Total items selected: 0 Total:<br>R 261 204,87 | |
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| License, EcoStruxure Control Expert, service pack base, small S, 1 user, node locked, digital license | |
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License, EcoStruxure Control Expert, with Topology Manager and M580 safety, for XL, node locked, 10 users, digital

R 246 769,59

View Product

3

Status Unavailable

Price Unavailable

View Details

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Content Training Installed Base Programs

Overview All Projects Project details

Project-21 Untitled

open

Created: 9/3/2025 Last Modified: 9/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

Add products to Bill of Materials

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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| Enclosures, thermal management, accessories and cabling | |
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| license, EcoStruxure Control Engineering, verification, basic, node locked, 1 shot | |

R 5 582,20

View Details

2

license, EcoStruxure Control Engineering,
documentation, basic, node locked, 1 shot

R 4 651,84

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By product reference number #

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| | license, EcoStruxure Automation Expert,<br>standard device runtime, add on, v23 | |
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| license, EcoStruxure Automation Expert, high availability option, runtime, add on, v23 | |
| R 840,00 | |
| View Details | |
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| license, EcoStruxure Automation Expert, run time, application, permanent, 1 user, for ATV dPac | |
| R 777,00 | |
| View Product | |

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| license, EcoStruxure Automation Expert, run time, application, permanent, 1 user, for M251, M262 dPAC | |
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| R 6 216,70 | |
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| license, EcoStruxure Automation Expert,<br>run time, application, permanent, 1 user,<br>for M580 dPAC | |
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| license, EcoStruxure Automation Expert,<br>run time, application, permannet, 1 user,<br>for M580 dPAC with extensions | |
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| license, EcoStruxure Automation Expert, run time, HMI, permanent, 1 user, for Harmony ST6 | |
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Overview All Projects Project details

Project-19 Untitled

open

Created: 5/3/2025 Last Modified: 5/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

Add products to Bill of Materials

By product reference number #

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| By Excel/CSV file ( Download sample template ) | |
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| By product segments / selection tools | |
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| Programmable controllers and I/Os | |
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| PLC, PAC, IOs and Power supplies | |
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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Interface, Safety and Control Relays | |
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| Electromechanical, Control, Timing and Solid State Relays | |
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| Enclosures and Accessories | |
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| Enclosures, thermal management, accessories and cabling | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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| Harmony ranges | |
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| Motion Control and Robotics | |
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| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
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| Power Control and Protection | |

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| Power supplies and transformers | |
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| Software License Configurator | |
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| Software License Configurator | |
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| Bill of Materials | |
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| Total items selected: 0 Total: R 64 222,36 | |
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| Motion controller LMC100 0 axis - Acc kit<br>- Basic | |
| | |

End of commercialisation: 12/01/2024

Price Unavailable

View Details

2

Regulated switch power supply, modicon power supply, 3 phases, 380 to 500V AC, 24V, 20A

R 13 112,60

View Product

3

| | |
|---|---|
| battery control module, phaseo ABL7<br>ABL8, 24 to 28.8V DC, phaseo ABL7 ABL8,<br>24V, 20A, for regulated SMPS | |
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| R 11 849,78 | |
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| View Product | |
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| battery control module, phaseo ABL7<br>ABL8, 24 to 28.8V DC, phaseo ABL7 ABL8,<br>24V, 40A, for regulated SMPS | |
| | |
| R 17 709,70 | |
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View Product

5

redundancy module, phaseo ABL7 ABL8, 40A, for regulated SMPS

R 5 529,38

View Product

6

electronic protection module, phaseo ABL7 ABL8, 28 to 28.8V DC, 10A, for regulated SMPS, 2 pole breaking by channel

R 8 177,54

View Product

7

buffer module, phaseo ABL7 ABL8, 24 to 28.8V DC, 40A, for power supply

R 7 843,36

View Product

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Overview All Projects Project details

Project-18 Untitled

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Created: 5/3/2025 Last Modified: 5/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

Add products to Bill of Materials

By product reference number #

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| By product segments / selection tools | |
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| Programmable controllers and I/Os | |
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| PLC, PAC, IOs and Power supplies | |
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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Interface, Safety and Control Relays | |
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| Electromechanical, Control, Timing and Solid State Relays | |
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| Enclosures, thermal management, accessories and cabling | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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| Harmony ranges | |
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| Motion Control and Robotics | |
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| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
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| Power Control and Protection | |

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| Power supplies and transformers | |
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| Software License Configurator | |
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| Bill of Materials | |
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| Total items selected: 0 Total: R 13 327,65 | |
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| | |
| Bus coupler, TeSys island, 24VDC, Ethernet switch (EtherNet IP / Modbus TCP) | |
| | |

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|---|---|---|
| | R 8 961,41 | |
| | | |
| | View Product | |
| | | |
| | 2 | |
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| | Voltage interface module, TeSys island, 690VAC 47-63 Hz, Isolated switching input for safe stop | |
| | R 4 366,24 | |
| | | |
| | View Product | |

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Overview All Projects Project details

Project-18 Untitled

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Created: 5/3/2025 Last Modified: 5/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

Add products to Bill of Materials

By product reference number #

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| Programmable controllers and I/Os | |
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| PLC, PAC, IOs and Power supplies | |
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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Power supplies and transformers | |
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| Bill of Materials | |
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| Total items selected: 0 Total: R 13 327,65 | |
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| | |
| Bus coupler, TeSys island, 24VDC, Ethernet switch (EtherNet IP / Modbus TCP) | |
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| | R 8 961,41 | |
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| | View Product | |
| | | |
| | 2 | |
| | | |
| | Voltage interface module, TeSys island, 690VAC 47-63 Hz, Isolated switching input for safe stop | |
| | R 4 366,24 | |
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| | View Product | |

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Overview All Projects Project details

Project-17 Untitled

open

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BOM Manager Activity Log Documents

Add products to Bill of Materials

By product reference number #

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| By product segments / selection tools | |
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| Programmable controllers and I/Os | |
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| PLC, PAC, IOs and Power supplies | |
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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Enclosures, thermal management, accessories and cabling | |
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| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
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| Power supplies and transformers | |
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| Total items selected: 0 Total:<br>R 385 363,62 | |
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| redundant processor, Modicon M580, 8MB, 61 Ethernet devices, 8 local racks, 8 remote IO racks | |
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| R 177 037,09 | |
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| power supply module, Modicon X80, 24V DC, 16.8W | |
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| R 7 707,26 | |
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| connector kit, Modicon M340, 2 removable connectors, cage clamp, for power supply module | |
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| R 527,05 | |
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| View Product | |
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| connector kit, Modicon M340, 2 removable connectors, spring type, for power supply module | |
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| R 561,57 | |
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| View Product | |
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rack, Modicon X80, 8 slots, Ethernet backplane

R 6 848,84

View Product

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Overview All Projects Project details

Project-16 Untitled

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Add products to Bill of Materials

By product reference number #

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| By product segments / selection tools | |
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| Programmable controllers and I/Os | |
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| PLC, PAC, IOs and Power supplies | |
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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Interface, Safety and Control Relays | |
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| Electromechanical, Control, Timing and Solid State Relays | |
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| Enclosures, thermal management, accessories and cabling | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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| Harmony ranges | |
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| Motion Control and Robotics | |
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| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
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Power supplies and transformers

Software License Configurator

Software License Configurator

Bill of Materials

Total items selected: 0 Total: 00.00

You don't have any products added in the BOM yet. You can access

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Understanding
overcurrent protection

How to select a Circuit Breaker

How to Protect
Against Electrocution

[How to select the Type of Residual Current Device according to the application]

Discover the Easy9 system

Discover the Acti9 System: M1

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Electrical Installation Design

Motor Starters with Contactors

Motor Protections

Operation and Maintenance Tool

Safety & Availability

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Industrial Automation market solutions

Find new business opportunities in Industrial Automation Market — skill up starting today

Learn more about Schneider Electric products and solutions for Industrial Automation market. Develop the expertise and upskill yourself to be fully equipped with important knowledge to better serve industrial customers. In this chapter, you will find basic short courses introducing an overview on key ranges. eLearnings will help to increase your technical capabilities allowing you to deliver sustainable growth and gain new business perspectives on Industrial Automation market with Schneider Electric.

Drives Basics

Control & Signaling

Basic HMIs

Relays

Power Supplies and
Universal Enclosures

Altivar Soft Starter & Variable Speed Drives

Secure Power solutions for data centers, critical power infrastructure and small offices

| | | |
|---|---|---|
| | Gain new knowledge about Secure Power solutions | |
| | | |
| | Discover the innovative, reliable, and energy-efficient solutions for critical power infrastructure and medium-large edge and data centers. Improve your competencies in UPS technology and the edge network. Explore Schneider's ranges of Single Phase and 3 Phase UPS systems — the fully integrated, end-to-end uninterruptible power supply solutions helping to maintain enterprise-wide networks, data centers, mission-critical systems, and industrial manufacturing processes. | |
| | | |

The Schneider Electric UPS Family

The Small Office and Home Office for Sales Associates

Edge Network

| | |
|---|---|
| Digital Power solutions to increase energy efficiency | |
| | |
| Digital Power solutions help you increase electrical system and assets reliability for your customers, avoid downtime by preventing power failures, and save money by reducing energy use and maintenance. In this chapter you will find introductory courses on the technical characteristics, functions, and applications of key product ranges. | |
| | |
| | |
| | |
| Basic Power Metering | |

Learn about PowerTag, how to promote it, and how it contributes to the different digital systems in each segment. Learn about PM2000, how to install and program these meters

Discover PowerTag Energy Sensors

EasyLogic PM2000

| | |
|---|---|
| Gateways and Energy Servers | |
| | |
| The EcoStruxure Panel Server Portfolio Overview provides the trainee with an overview of SE gateways and energy server offers | |
| | |

| | |
|---|---|
| EcoStruxure Panel Server | |
| | |
| | |
| Power Quality and Power Factor Correction | |
| | |

Gain more knowledge in Power Quality and Power Factor Correction in short videos

[Power Quality and LV Power Factor Correction]

LV Power Factor
Correction components

| | |
|---|---|
| Selection of the right LV Capacitor | |
| | |
| | |
| | |
| Protection Relays | |
| | |

This course provides an overview of offer values and ways to address customer pain points

Easergy P1

Sustainability School

Gain sustainability knowledge and skills

Chapter 1: Gain knowledge

Business and sustainability go hand in hand today. In fact, the survival of our planet depends on it. Sparked by Electricity 4.0 and the rise of electrification and digitalisation, the Schneider Electric Sustainability School is your pathway to in-demand expertise and practical tools. Elevate your brand’s reputation and stand apart from the competition. Start with Chapter 1 of Schneider Electric Sustainability school and get a clear understanding of sustainability basics like climate science, scope of impact, and tracking metrics to inform your customers and gain a competitive edge. Chapters 2 and 3 are coming soon.

Top of Form

Skip to main content

Show Navigation Menu

Tshingombe fiston

Student

Navigation Menu

My Training Home

| | |
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| Welcome | |
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| Learning | |
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| Support | |
| | |

Schneider Electric Personalized Experience

My Account

Help

Log Out

Main content below

Learner Home

42

Completions

0

Hours

Your Subjects

Bottom of Form

Business Acumen, Cross-Functional, Customer Project Management, Customer Projects & Services, Digital, Digital Technologies, DLC Canada, DLC US, EcoStruxure - Innovation At Every Level, EcoStruxure for Building, EcoStruxure Plant, Electrical Distribution Services, Electrical safety and Lockout Tagout, Electrical Engineering, Field Services Business Effectiveness, Field Services Market and Customers, Fire, Chemical, PPE, Road and Emergency, Functional, Health & Safety, HMI (Terminals and Industrial PC), Industrial Automation and Control, Industrial Automation and Control Software, Industrial Communication, Industry Specific, Information Technology, IT Applications, IT Security, LegacySubject35DND, Low Voltage Products and Systems, Management and Leadership, Managing Change, Onboarding, Onboarding for All Employees, PLC, PAC and dedicated Controllers, Products, Solutions & Services, Safety, Safety Principles, Sales, Sales & Service, Sales Knowledge, Sales

Your Playlists

0

Created

0

Followers

0

Followed

Hi Tshingombe! What would you like to learn today?

Continue Learning

Curriculum

[Schneider Home Certification]

| | |
|---|---|
| In Progress | |
| | |
| Open Curriculum | |
| | |
| | |
| | |
| Curriculum | |
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| In Progress | |
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| Curriculum | |
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| Curriculum | |
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| In Progress | |
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| Curriculum | |
| | |

In Progress

Saved for Later

Curriculum

Sustainability School for Partners
Chapter 2

In Progress

| | |
|---|---|
| Launch | |
| | |
| Most Popular | |
| | |
| | |
| | |
| Online Class | |
| | |

The Thermal Management Functions in Electrical Panels: Module 02

30 minutes

| | |
|---|---|
| Online Class | |
| | |
| 30 minutes | |
| | |
| | |
| Online Class | |
| | |

| | |
|---|---|
| 30 minutes | |
| | |
| | |
| | |
| Video | |
| | |
| 55 minutes | |
| | |
| | |
| | |
| Test | |
| | |

30 minutes

Top of Form

Bottom of Form

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Open Curriculum

Curriculum

EBO 2023: Engineering EasyLogic

In Progress

Open Curriculum

Curriculum

| | |
|---|---|
| [EBO 2023: Engineering Upgrade] | |
| | |
| | |
| | |
| In Progress | |
| | |

Open Curriculum

Curriculum

EcoXpert Smart Grid, Technical, Intermediate: Geographic Information Systems Path

In Progress

Open Curriculum

Online Class

EcoStruxure Power Foundational 2.0

In Progress

Launch

Event

[Advanced Machines with PacDrive 3 [VILT]]

| | |
|---|---|
| 20 hours | |
| | |
| | |
| | |
| | |
| | |
| Online Class | |
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EcoStruxure Building: Graphics Editor Intermediate

In Progress

Online Class

Fundamentals of Thermal Management in Electrical Panels: Module 01

| | |
|---|---|
| 30 minutes | |
| | |
| | |
| | |
| | |
| | |
| Video | |
| | |

| | |
|---|---|
| SP_MX_2021_Lanzamiento Square D Easy UPS 3S 10-40 kVA (208V) | |
| | |
| | |
| | |
| 55 minutes | |
| | |
| | |
| | |
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| | |
|---|---|
| Test | |
| | |
| IT Solution Provider Certification<br>Test - Select | |
| | |
| | |
| | |
| 30 minutes | |
| | |
| | |

Sustai

Top of Form

Skip to main content

Show Navigation Menu

Main content below

Tshingombe fiston

Bio

Transcript

Actions

Home

Tshingombe fiston

My Courses: Tshingombe fiston

My Courses: Tshingombe fiston

Use the transcript to manage all active training.

0 HRS

AGGREGATE TRAINING
COMPLETED

| | |
|---|---|
| FISCAL YEAR ENDING | |
| 12/31/2025 | |
| COST | |
| R0.00 | |

Filter by Training Status

Active

Sort by

Date Added

Filter by Training Type

All Types

Search by Keyword

Search

Search Results (134)

Schneider Home
Certification

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

Bottom of Form

EcoXpert Smart Grid, Technical, Intermediate: Geographic Information Systems Path

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

Basic Machines with
PacDrive 3 [VILT] (Test)

Due : No Due Date
Status : Failed Training
Type : Test Training
Status : Active

Cybersecurity für
Schneider Electric
Service Partner /
Cybersecurity for
Schneider Electric
Services Partners
(German)

Due : No Due Date
Status : In Progress
Training Type : Online
Class Training Status :
Active

EBO 2023: Engineering
EasyLogic

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

Service for Lexium [VILT]
(Test)

Due : No Due Date
Status : Failed Training
Type : Test Training
Status : Active

20 Mobile Terms You
Probably Know

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

EBO 2022: Engineering
EBO

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

EBO 2023: Engineering
EBO

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

EBO 2024: Engineering
EBO

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

EBO 2022: Value Based Selling

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

DIN Ethernet Technical Overview

Due : No Due Date
Status : In Progress
Training Type : Online
Class Training Status :
Active

Applying OWASP 2017
Mitigations Series

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

EcoStruxure Power
Foundational 2.0

Due : No Due Date
Status : In Progress
Training Type : Online
Class Training Status :
Active

Fundamentals of Threat Modeling

Due : No Due Date
Status : In Progress
Training Type : Online
Class Training Status :
Active

Sustainability School for
Partners Chapter 2

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

Basic Machines with
PacDrive 3 (Test)

Due : No Due Date
Status : Failed Training
Type : Test Training
Status : Active

EcoStruxure Building Technical Training For EcoXperts 2023 - Proficient

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

Introduction to EcoCare
: Next Generation
Services Membership

Due : No Due Date
Status : Registered
Training Type : Online
Class Training Status :
Active

Escola de Sustentabilidade para Parceiros. Capítulo 1/Sustainability School for Partners. Chapter 1 (Portuguese)

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

Motion Block : Part I
(Test)

Due : No Due Date
Status : Failed Training
Type : Test Training
Status : Active

Transformers and motor applications in industries

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

EBO 2023: Engineering Upgrade

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

PowerLogic P5:
Protection Engineering

Due : No Due Date
Status : In Progress
Training Type :
Curriculum Training
Status : Active

EVlink ProAC Calibration
Law Compliant Basic
(German)

Due : No Due Date
Status : Registered
Training Type : Online
Class Training Status :
Active

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1

2

3

4

5

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Last

1 to 25 of 134

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Product Selector Tool

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the product selection process.

| |
|---|
| |
| |
| Try our Product Selector |
| |
| Top of Form |
| |
| Bottom of Form |
| |
| Content Training Installed Base Programs |
| |
| Overview All Projects Project details |
| |
| Project-28 Untitled |
| |
| open |
| |

| | |
|---|---|
| Created: 9/3/2025 Last Modified: 17/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering engineerig | |
| BOM Manager Activity Log Documents | |
| | |
| Add products to Bill of Materials | |
| | |
| By product reference number # | |
| | |

| | |
|---|---|
| By Excel/CSV file ( Download sample template ) | |
| | |
| Error adding products View BOM | |
| | |
| By product segments / selection tools | |
| | |
| Programmable controllers and I/Os | |
| | |
| PLC, PAC, IOs and Power supplies | |
| | |
| Motor Protection & Control | |
| | |

| | |
|---|---|
| VSD, Soft Starter, Direct Starter and protections | |
| | |
| Human-machine interfaces | |
| | |
| HMI panels, controllers, software and Industrial PCs | |
| | |
| Interface, Safety and Control Relays | |
| | |
| Electromechanical, Control, Timing and Solid State Relays | |
| | |
| Enclosures and Accessories | |
| | |

| | |
|---|---|
| Enclosures, thermal management, accessories and cabling | |
| | |
| Push Buttons, Switches, Pilot Lights and Joysticks | |
| | |
| Harmony ranges | |
| | |
| Motion Control and Robotics | |
| | |
| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
| | |
| Power Control and Protection | |

| | |
|---|---|
| Power supplies and transformers | |
| | |
| Software License Configurator | |
| | |
| Software License Configurator | |
| | |
| Bill of Materials | |
| | |
| Total items selected: 1 Total: R 30 687,22 | |
| | |
| 1 | |
| | |
| Controller, Modicon M171/M172/M173,<br>optimized display 22 IO, Modbus | |
| | |

| | |
|---|---|
| R 9 888,63 | |
| | |
| View Product | |
| | |
| 2 | |
| | |
| Modicon M171 Optimized LV Connector<br>1m cable | |
| | |
| R 555,78 | |
| | |
| View Product | |
| | |
| 3 | |
| | |
| Modicon M171 Optimized AO Connector<br>1m cable | |
| | |
| R 140,86 | |
| | |
| View Product | |
| | |
| 4 | |
| | |
| Modicon M171 Optimized AO Connector<br>2m cable | |
| | |

| | |
|---|---|
| R 201,24 | |
| | |
| View Product | |
| | |
| 5 | |
| | |
| Modicon M171 Optimized Display LED | |
| | |
| R 1 802,40 | |
| | |
| View Product | |
| | |
| 6 | |
| | |
| Modicon M171 Optimized Display LCD | |
| | |
| End of commercialisation: 12/01/2024 | |
| | |
| R 3 104,58 | |
| | |
| View Product | |
| | |
| 7 | |
| | |

Modicon M171 Optimized Wall thermostat without backlight

R 2 170,34

View Product

8

NTC 1,5m IP68 5x20 -50+110°C Grey

R 143,76

View Product

9

NTC 1,5m IP68 5x20 -50+110°C Grey

R 136,69

View Product

10

| | |
|---|---|
| NTC 3,0m IP68 5x20 -50+110°C Grey | |
| | |
| End of commercialisation: 12/01/2024 | |
| | |
| R 229,99 | |
| | |
| View Product | |
| | |
| 11 | |
| | |
| EEV Driver, Actuator | |
| | |
| End of commercialisation: 01/23/2021 | |
| | |
| R 3 449,54 | |
| | |
| View Product | |
| | |
| 12 | |
| | |
| EEV Driver, Autonomous & Hardwired | |

End of commercialisation: 01/23/2021

R 3 737,01

View Product

13

EEV Driver, Autonomous & Modbus

End of commercialisation: 12/01/2024

R 4 570,62

View Product

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Product Selector Tool

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Content Training Installed Base Programs

Overview All Projects Project details

Project-27 Untitled

open

Created: 9/3/2025 Last Modified: 9/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

Add products to Bill of Materials

By product reference number #

| | |
|---|---|
| By Excel/CSV file ( Download sample template ) | |
| | |
| Error adding products View BOM | |
| | |
| By product segments / selection tools | |
| | |
| Programmable controllers and I/Os | |
| | |
| PLC, PAC, IOs and Power supplies | |
| | |
| Motor Protection & Control | |
| | |

| | |
|---|---|
| VSD, Soft Starter, Direct Starter and protections | |
| | |
| Human-machine interfaces | |
| | |
| HMI panels, controllers, software and Industrial PCs | |
| | |
| Interface, Safety and Control Relays | |
| | |
| Electromechanical, Control, Timing and Solid State Relays | |
| | |
| Enclosures and Accessories | |
| | |

| | |
|---|---|
| Enclosures, thermal management, accessories and cabling | |
| | |
| Push Buttons, Switches, Pilot Lights and Joysticks | |
| | |
| Harmony ranges | |
| | |
| Motion Control and Robotics | |
| | |
| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
| | |
| Power Control and Protection | |

| | |
|---|---|
| Power supplies and transformers | |
| | |
| Software License Configurator | |
| | |
| Software License Configurator | |
| | |
| Bill of Materials | |
| | |
| Total items selected: 0 Total: R 30 687,22 | |
| | |
| 1 | |
| | |
| Controller, Modicon M171/M172/M173,<br>optimized display 22 IO, Modbus | |
| | |

| | |
|---|---|
| R 9 888,63 | |
| | |
| View Product | |
| | |
| 2 | |
| | |
| Modicon M171 Optimized LV Connector<br>1m cable | |
| | |
| R 555,78 | |
| | |
| View Product | |
| | |
| 3 | |
| | |
| Modicon M171 Optimized AO Connector<br>1m cable | |
| | |
| R 140,86 | |
| | |
| View Product | |
| | |
| 4 | |
| | |
| Modicon M171 Optimized AO Connector<br>2m cable | |
| | |

| | |
|---|---|
| R 201,24 | |
| | |
| View Product | |
| | |
| 5 | |
| | |
| Modicon M171 Optimized Display LED | |
| | |
| R 1 802,40 | |
| | |
| View Product | |
| | |
| 6 | |
| | |
| Modicon M171 Optimized Display LCD | |
| | |
| End of commercialisation: 12/01/2024 | |
| | |
| R 3 104,58 | |
| | |
| View Product | |
| | |
| 7 | |
| | |

Modicon M171 Optimized Wall thermostat without backlight

R 2 170,34

View Product

8

NTC 1,5m IP68 5x20 -50+110°C Grey

R 143,76

View Product

9

NTC 1,5m IP68 5x20 -50+110°C Grey

R 136,69

View Product

10

| | |
|---|---|
| NTC 3,0m IP68 5x20 -50+110°C Grey | |
| | |
| End of commercialisation: 12/01/2024 | |
| | |
| R 229,99 | |
| | |
| View Product | |
| | |
| 11 | |
| | |
| EEV Driver, Actuator | |
| | |
| End of commercialisation: 01/23/2021 | |
| | |
| R 3 449,54 | |
| | |
| View Product | |
| | |
| 12 | |
| | |
| EEV Driver, Autonomous & Hardwired | |

End of commercialisation: 01/23/2021

R 3 737,01

View Product

13

EEV Driver, Autonomous & Modbus

End of commercialisation: 12/01/2024

R 4 570,62

View Product

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Overview All Projects Project details

Project-27 Untitled

open

Created: 9/3/2025 Last Modified: 9/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

View :

thesis atlantic car... Successfully Scanned
Owner Owner 17/3/2025 17/3/2025
10:09:24 AM Set Date

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Content Training Installed Base Programs

Overview All Projects Project details

Project-26 Untitled

open

Created: 9/3/2025 Last Modified: 9/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

Add products to Bill of Materials

By product reference number #

| | |
|---|---|
| By Excel/CSV file ( Download sample template ) | |
| | |
| Error adding products View BOM | |
| | |
| By product segments / selection tools | |
| | |
| Programmable controllers and I/Os | |
| | |
| PLC, PAC, IOs and Power supplies | |
| | |
| Motor Protection & Control | |
| | |

| | |
|---|---|
| VSD, Soft Starter, Direct Starter and protections | |
| | |
| Human-machine interfaces | |
| | |
| HMI panels, controllers, software and Industrial PCs | |
| | |
| Interface, Safety and Control Relays | |
| | |
| Electromechanical, Control, Timing and Solid State Relays | |
| | |
| Enclosures and Accessories | |
| | |

| | |
|---|---|
| Enclosures, thermal management, accessories and cabling | |
| | |
| Push Buttons, Switches, Pilot Lights and Joysticks | |
| | |
| Harmony ranges | |
| | |
| Motion Control and Robotics | |
| | |
| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
| | |
| Power Control and Protection | |

| | |
|---|---|
| Power supplies and transformers | |
| | |
| Software License Configurator | |
| | |
| Software License Configurator | |
| | |
| Bill of Materials | |
| | |
| Total items selected: 0 Total: R 51 005,44 | |
| | |
| 1 | |
| | |
| Motion controller LMC216 16 axis - Acc<br>kit - Basic | |
| | |

End of commercialisation: 12/01/2024

Price Unavailable

View Details

2

Regulated switch power supply, modicon power supply, 3 phases, 380 to 500V AC, 24V, 20A

R 13 112,60

View Product

3

| | |
|---|---|
| Motor circuit breaker, TeSys Deca, 3P, 1 to 1.6A, thermal magnetic, screw clamp terminals, button control | |
| | |
| R 1 709,72 | |
| | |
| View Product | |
| | |
| 4 | |
| | |
| battery control module, phaseo ABL7 ABL8, 24 to 28.8V DC, phaseo ABL7 ABL8, 24V, 20A, for regulated SMPS | |
| | |
| R 11 849,78 | |
| | |

| | |
|---|---|
| View Product | |
| | |
| 5 | |
| | |
| battery control module, phaseo ABL7<br>ABL8, 24 to 28.8V DC, phaseo ABL7 ABL8,<br>24V, 40A, for regulated SMPS | |
| | |
| R 17 709,70 | |
| | |
| View Product | |
| | |
| 6 | |
| | |
| Easy UPS control module, 24V DC-DC,<br>DIN Rail, Industrial, 20A | |
| | |
| R 3 679,82 | |
| | |
| View Product | |

7

Easy UPS battery module, 24V DC-DC,
DIN Rail, Industrial, 4.5Ah

R 2 943,82

View Product

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Top of Form

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Content Training Installed Base Programs

Overview All Projects Project details

Project-25 Untitled

open

Created: 9/3/2025 Last Modified: 9/3/2025 Project Owner: Tshingombe fiston End User Company: Tshingombe engineering

BOM Manager Activity Log Documents

Add products to Bill of Materials

By product reference number #

| | |
|---|---|
| By Excel/CSV file ( Download sample template ) | |
| | |
| Bill of Materials | |
| | |
| Total items selected: 0 Total: R 400 547,09 | |
| | |
| 1 | |
| Circuit breaker, ComPacT NSX400H, 70kA/415VAC, 3 poles, MicroLogic 1.3M trip unit 320A | |
| | |
| R 14 080,25 | |
| | |
| View Product | |
| | |

| | |
|---|---|
| 2 | |
| | |
| Contactor body,TeSys F,3P(3NO)-AC-3,<br><=440V 265A without coil | |
| | |
| End of commercialisation: 12/31/2023 | |
| | |
| R 28 920,36 | |
| View Product | |
| | |
| 3 | |
| | |
| variable speed drive, Altivar Process<br>ATV900, ATV930, 160kW, 380 to 480V,<br>with braking unit, IP20 | |

| | |
|---|---|
| | |
| R 334 238,57 | |
| | |
| View Product | |
| | |
| 4 | |
| | |
| Low level auxiliary contact, circuit breaker status OF/SD/SDE/SDV, 1 changeover contact type | |
| | |
| R 1 005,92 | |
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Low level auxiliary contact, circuit breaker status OF/SD/SDE/SDV, 1 changeover contact type

R 1 005,92

View Product



Low level auxiliary contact, circuit breaker status OF/SD/SDE/SDV, 1 changeover contact type

R 1 005,92

View Product

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| torque limiting screws, ComPact NSX400/630, power connections, set of 12 parts | |
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| End of commercialisation: 12/01/2024 | |
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| R 489,96 | |
| View Product | |
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| 8 | |
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| TeSys F - suppressor module - RC circuit - 127...240 V AC | |
| | |
| End of commercialisation: 12/31/2023 | |
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| | R 1 344,07 | |
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| | Time delay auxiliary contact block, TeSys Deca, 1NO+1NC, on delay 0.3-3s, front, screw clamp terminals | |
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| | R 2 151,05 | |
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| | Time delay contact block,TeSys Deca,1NO+1NC,on-delay 1-30s,front | |
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R 2 151,05

View Product

11

TeSys F - main contact set - 3P

End of commercialisation: 12/31/2023

R 14 154,02

View Product

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| PLC, PAC, IOs and Power supplies | |
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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Electromechanical, Control, Timing and Solid State Relays | |
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| Enclosures and Accessories | |
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| Enclosures, thermal management, accessories and cabling | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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| Harmony ranges | |
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| Motion Control and Robotics | |
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| Move the machine tooling or the part itself in a controlled, rotary or linear manner. | |
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| Power Control and Protection | |

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| Power supplies and transformers | |
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Circuit breaker, ComPacT NSX400H,
70kA/415VAC, 3 poles, MicroLogic 1.3M
trip unit 320A

R 14 080,25

View Product



Contactor body,TeSys F,3P(3NO)-AC-3,
<=440V 265A without coil

End of commercialisation: 12/31/2023

R 28 920,36

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| View Product | |
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| soft starter for asynchronous motor,<br>Altistart 22, control 230V, 230 to 440V,<br>75 to 132kW | |
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| R 65 378,96 | |
| View Product | |
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| torque limiting screws, ComPact<br>NSX400/630, power connections, set of<br>12 parts | |
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| End of commercialisation: 12/01/2024 | |
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| R 489,96 | |
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| Auxiliary contact block, TeSys Deca, 1NC,<br>front mounting, screw clamp terminals | |
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| R 277,79 | |
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Auxiliary contact block, TeSys Deca, 1NO+1NC, front mounting, screw clamp terminals

R 350,84

View Product



Auxiliary contact block, TeSys Deca, 1NO+3NC, front mounting, screw clamp terminals

R 600,08

View Product

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| Motor Protection & Control | |
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| VSD, Soft Starter, Direct Starter and protections | |
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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Electromechanical, Control, Timing and Solid State Relays | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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| Power supplies and transformers | |
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| Total items selected: 0 Total: R 17 164,53 | |
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|---|---|
| Motor circuit breaker, TeSys GV4, 3P, 115A, Icu 50kA, thermal magnetic, Everlink terminals | |
| Price Unavailable | |
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| Contactor, TeSys Deca, 3P(3NO), AC-3/AC-3e, <=440V, 115A, 230V AC 50/60Hz coil, screw clamp terminals | |

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| R 9 642,90 | |
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| Auxiliary contact, TeSys GV4, 690VAC, 1 NO/NC | |
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| R 606,49 | |
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| Auxiliary contact, TeSys GV4, 690VAC, 1 NO/NC | |
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| R 606,49 | |
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|---|---|
| Time delay auxiliary contact block, TeSys Deca, 1NO+1NC, on delay 10-180s, front, screw clamp terminals | |
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| R 2 393,92 | |
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| View Product | |
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| Contactor coil, TeSys Deca, LX1D8, 230V AC 50/60Hz for 115 and 150A contactor | |
| | |
| R 3 914,73 | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Interface, Safety and Control Relays | |
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| Electromechanical, Control, Timing and Solid State Relays | |
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| Enclosures, thermal management, accessories and cabling | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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License, EcoStruxure Control Expert, with Topology Manager and M580 safety, for XL, node locked, 10 users, digital

R 246 769,59

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Price Unavailable

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| Human-machine interfaces | |
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| HMI panels, controllers, software and Industrial PCs | |
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| Push Buttons, Switches, Pilot Lights and Joysticks | |
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R 5 582,20

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license, EcoStruxure Control Engineering,
documentation, basic, node locked, 1 shot

R 4 651,84

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Project 2025.03.17#17898

Help

Project
2025.03.17

Total
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Project
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ATS22C59S6U

soft starter for asynchronous motor,
Altistart 22, control 110V, 230 to 575V,
200 to 500hp

Datasheet

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ATS22C59S6U

soft starter for asynchronous motor,
Altistart 22, control 110V, 230 to 575V,
200 to 500hp

Datasheet

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en_US.json 2017/10/19 09:44:14

1 item(s) selected.Fundamentals of Health Care Facility Electrical Power

Course Outline

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Course Description

With daunting aspects such as ever-changing codes and standards, increasing medical complexity and dwindling capital budgets, hospitals and health care facilities are among the most challenging building projects. Health care facility electrical systems are complex, difficult to design, expensive to build and

subject to a plethora of codes and standards as well as intensely regulated by authorities having jurisdiction over their design and construction. With new medical technologies continuing to healthcare facility electrical systems are ever changing.

This course provides an introduction to the topic of healthcare facility electrical

Course Outline

Course Objectives

- Recognize the importance of electrical distribution to health care facilities, and other types of buildings
- Identify the codes, standards and guidelines which govern the design of electrical systems
- Describe the elements of a health care facility's Essential Electrical System

Course Content or Material

1) Introduction

2) Different types of health care facilities have differing needs and code distribution

a. Hospitals

b. Long-term care facilities

c. Ambulatory surgery facilities

d. Outpatient therapy facilities

e. Outpatient facilities

f. Clinics and physician offices

3) The importance of electrical distribution to hospitals

a. Life support

i. Patients on ventilators

ii. General anesthesia

b. Medical procedures

c. Medical records

d. Comfort

e. Life Safety (fire safety)

i. Illumination of the means of egress

f. Without electrical power, a medical facility will close and/or be evacuated

4) Codes, standards and guidelines

a. NFPA 101



Course Outline

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b. NFPA 99

c. NFPA 110 and 111

d. NFPA 70

e. NFPA 70E

f. Electrical safety for those who work on electrical gear
f. FGI Guidelines
g. CMS
h. OSHA
5) Essential Electrical System
a. Alternate source of power
i. Classification of the emergency power system
b. Branches of the essential electrical system
i. Example: Type I systems
1. Life Safety Branch
2. Critical Branch
3. Equipment Branch
ii. Type 2 and Type 3 systems
c. Potential failure points within the essential electrical system
6) Assessing the need for providing an alternate source of power
7) Summary
Course Assessment: Test Your Knowledge

Course Survey: We Value Your Opinion

Leaderboard

2350 points 4732nd

1st level 32nd

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3 completed courses223rd

3 certificates235th

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<tshingombefiston@gmail.com> wrote:

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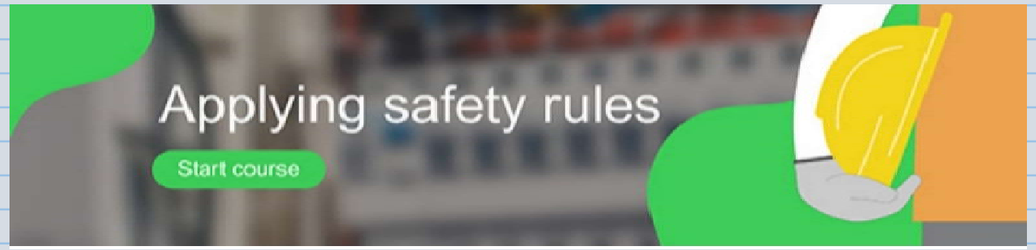
Course rating is 4.76 stars

By Language / English

Applying Safety Rules

Student




Duration*: 20 minutes*

Outline*:*

In this course, you will learn how to avoid electrical hazards as a professional by ensuring safety on the job site. You will learn about safety equipments and rules to follow to protect the installation, its users and yourself. You will also learn about some of the fundamental concepts of electricity to better understand its dangers and the importance of product sizing.

At the end of this course, you will be able to:

- To define principles safety rules

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| - To know standard safety equipment and specific PPE | |
| | |
| - To memorize gestures and habits to be safe during an intervention | |
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To achieve it, you will get access to a composition of materials as procedure block, flashcards, podcasts, interactive images and professional case studies.

Have a good journey!

*This course was made possible thanks to an international collaboration:*

| | |
|---|---|
| • *Schneider Electric education team ;* | |
| | |
| • *Eric Dupont, a teacher affiliated with the French Ministry of National Education ;* | |
| | |
| • *ItyCom, a leading provider of digital learning solutions ;* | |
| | |
| • *Cécile Lienaux, a graphic designer ;* | |
| | |

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Course content

Additional content has been loaded

Discover personal protective equipment

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Applying safety rules

0% COMPLETE

Discover personal protective equipment

Practical case

Electricity risks

Safety rules for working with electrical equipment

Test your knowledge

Conclusion

This lesson is currently unavailable

Must pass quiz before continuing: "Test your knowledge"

Home

Lesson content

Discover personal protective equipment

Lesson 1 of 6

We are happy to have you with us!

To start your safety training, you will learn how to choose the appropriate personal protective equipment in order to reduce the risks of injury and accidents, whether you're at work or at home.

Continued

Personal Protective Equipment (PPE)

## What is a Personal Protective Equipment (PPE)?

Personal protective equipment (PPE) is an important aspect of electrical safety, as it helps protect workers from electrical hazards.

Wearing PPE can help prevent injuries and fatalities due to electrical accidents.

It is important for workers to use the appropriate PPE for the task they are performing, and to ensure that it is in good condition and properly maintained.

What to wear to be safe during an installation?

Here is a list of basic personal protective equipment:

*Click on each tab below to learn about the different types of personal protective equipment:*

Protect the upper body.

When working on energized systems, do not pull up your sleeves.

This equipment is the standard, but it can change depending on the activities.

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Must pass quiz before continuing: "Test your knowledge"

Lesson 3 of 6

In this chapter you will learn more about electricity to better understand safety issues.

Continued

Electricity and its dangers

Why is it risky?

Electricity is a form of energy resulting from the presence and movement of charged particles, such as electrons. It is a fundamental force of nature that is responsible for lightning, electric currents, and electromagnetic radiation.

It is generated by the movement of charged particles. For example, in a battery, chemical reactions create a flow of electrons from the negative terminal to the positive terminal, creating a voltage difference.

Electricity can be dangerous:

In most businesses and households, the voltage of the electricity and the available electrical current have sufficient power to cause death by electrocution. Even changing a light bulb without first disconnecting the lamp can be dangerous because coming into contact with the “hot”, “energized”, or “live” part of the outlet could kill a person.

Analyzing Reliability in the Data Center
Outline

Course Description:

The growing reliance on information systems that operate 24 hours per day, 7 days per week, has

spawned a rapidly growing and developing industry that supplies products and services on

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| | demand. The need for these types of information services now reaches into every business office | |
| | | |
| | in the world. Unfortunately, events of all kinds including hardware failure, human error, | |
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environmental changes, structural failure and external events, can lead to the possibility of

unanticipated systems downtime.

Modern data centers do not tolerate planned downtime and strive for no outages in a 10-year

mission. Data center operations staffs are faced with the dilemma of either downtime as a result of

insufficient physical infrastructure, or incurring extensive costs by designing in more redundancies

than is necessary. Targeted reliability solutions allow businesses to meet individual requirements of

the data center, while minimizing the total cost of ownership.

In fact, very high reliability is difficult to attain and redundant hardware is only part of the answer.

This course will demonstrate some important performance success factors and overviews best

practices for analyzing and optimizing reliability.

Course Outline:

Learning Objectives

At the completion of this course, you will be able to:

§ Define key terms associated with analyzing reliability risks

§ Identify some common cause failures in the data center

§ Describe the benefits of conducting a Probabilistic Risk Assessment (PRA)

§ Recognize the reliability advantages of utilizing scalable, modular architecture in the data center

Agenda

§ Introduction

§ Analyzing risk

§ Redundancy

§ Common cause failures

§ Probabilistic Risk Assessment (PRA)

§ Case study example

§ Summary

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1) Introduction

a) Information systems need to operate 24 / 7

| | |
|---|---|
| b) Growing and developing industry supplies products and services on-demand | |
| | |
| c) Modern data centers do not tolerate planned downtime and strive for no outages in a 10- | |
| | |
| year mission | |
| | |
| d) Data center operations staffs are faced with | |
| | |

e) The dilemma of downtime as a result of insufficient physical infrastructure

f) Incurring extensive costs by factoring in unnecessary redundancies

g) Targeted reliability solutions allow businesses to meet individual requirements of the data

| | |
|---|---|
| center, while minimizing the total cost of ownership | |
| | |
| 2) Reliability | |
| | |
| a) Understanding how to best define downtime risk | |
| | |
| i) Is important to optimizing its reliability | |
| | |
| ii) Decreases total cost of ownership | |
| | |
| iii) Increases agility | |
| | |

b) Reliability metrics statistically analyze the likelihood of a failure occurring

3) Redundancy

a) While redundancy can increase reliability, there are significant costs and potentially

serious drawbacks

b) A redundant system has more components

| | |
|---|---|
| c) In general, systems with more components will experience more failures | |
| | |
| 4) Discussing Best Practices | |
| | |
| a) The design, manufacture, operation, maintenance and repair of equipment | |
| | |

| | |
|---|---|
| b) The gathering of data, and the review and publication of component benchmarking results | |
| | |
| c) Consistent deployment of the language of reliability, both definitions and assumptions | |
| | |
| d) A philosophy addressing the constant pursuit of root causes, common cause failures and | |
| | |

| | |
|---|---|
| relevant data | |
| | |
| 5) Modularity and Component Count | |
| | |
| a) Reliability can be increased through standardization | |
| | |
| b) Modularity is a powerful concept | |
| | |
| c) Modularizing a system can increase the number of internal components | |
| | |

d) Reliability analysis of modular systems must consider

i) Component design

ii) Function

iii) Dependencies

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a) Data center testing and maintenance practices often have a significant impact on systems

reliability

b) Testing and diagnosis can improve reliability, but may also degrade it

7) UPS: Historical Perspective

a) In most UPSs, utility AC power is rectified to DC

b) The inverter synthesizes an AC voltage free from the effects of spikes, sags, harmonics,

and brief utility outages

8) Assessing Reliability

a) Product support engineers

| | |
|---|---|
| i) Track the products' performance in actual use | |
| | |
| ii) Identify and implement changes necessary to correct deficiencies or defects | |
| | |
| iii) Benefit from a road map identifying components most likely to fail | |
| | |

b) Deviations from the predictions of the road map would identify new areas for more

intensive investigation and possible remedial action

9) The Correct Course of Action: PRA

a) The process of building the logical model results in a comprehensive review

| | |
|---|---|
| b) The mathematical nature of the calculation limits the logical fallacies that tend to dominate | |
| | |
| qualitative evaluation of reliability | |
| c) The implication is that if N components are required for success, there is one, two, twice | |
| | |

as many, or even twice plus one as many units available

d) Not all redundancy makes the same contribution to reliability

10) Reliability Assessment Case Study

a) The mathematical models that resulted from the analysis were used to answer some key

| | |
|---|---|
| questions | |
| | |
| b) The scalable, modular system utilizes redundancy in nearly all components as a means of | |
| | |
| achieving high reliability | |
| | |
| c) MTechnology, Inc's analysis showed that | |
| | |
| d) There are both costs and benefits to redundancy | |
| | |

e) Some sub-systems benefit less from redundancy than others

f) Complex mathematical formulas were utilized to calculate the case study failure rates and

common cause failures

11) Case study goals

a) To identify potential sources of failure

©2013 Schneider Electric. All rights reserved. All trademarks provided are the property of their respective owners.b) To evaluate the potential for further improvement in the scalable, modular power system’s

reliability and availability

12) Target of Case Study Analysis

a) Subjects of analysis

| | |
|---|---|
| | |
| i) 14 - 40 kW Scalable, modular, rack based power system with PDU and static bypass | |
| | |
| ii) 500 kW central UPS | |
| | |
| b) Tools utilized | |
| | |
| i) Probabilistic Risk Assessment (PRA) | |
| | |
| ii) Fault tree | |
| | |
| iii) Event tree analysis | |
| | |
| iv) Bayesian updating | |
| | |

13) Reliability Assessment Case Study

a) All actions have both beneficial and negative affects on reliability

b) It helps to support the uptime of the servers but also can represent a point of failure

14) Comparing Modularity to the Central UPS

a) The scalable, modular system loses power to all loads only when

i) The main entrance bus fails

ii) The transfer switch fails to open

b) The probability of all 14 scalable, modular units failing simultaneously due to internal

failures is extremely low

| | |
|---|---|
| c) PDU failure will cause partial load drop | |
| | |
| d) Only one circuit breaker after the transfer switch will cause all critical loads to fail | |
| | |
| 15) Central UPS data | |
| | |
| a) Battery failure is a significant contributor of failure in central UPS | |
| | |

b) The central UPS can fail internally, and bypass can fail, causing all loads to fail

c) PDU failure will cause partial load drop

16) Reliability Assessment Case Study: The Findings

a) The calculated reliability of the scalable, modular power system is comparable to data

| | | |
|---|---|---|
| | published by vendors of large, central UPSs | |
| | | |
| | b) The scalable, modular power system is significantly less likely to suffer a complete system failure | |
| | | |
| | c) The redundancy provided in the scalable, modular power system definitely improves the product's reliability | |
| | | |

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a) Overall, the scalable, modular architecture had a system failure rate was approximately

| | |
|---|---|
| 40% lower than that of the central UPS system | |
| | |
| b) Failure is defined as the loss of power for all critical loads | |
| | |
| c) Discounting battery failures, the scalable, modular failure rate is still approximately 18% | |
| | |

| | |
|---|---|
| less than that of a comparable central UPS architecture | |
| | |
| d) If failure is defined to include dropping of any single load due to a branch circuit failure, but | |
| | |
| not UPS failure, the scalable, modular architecture is 6% less likely to fail | |
| | |

e) Scalable, modular power system architecture proved more reliable than the single module

UPS with a single battery string

f) The redundant subsystems within the scalable, modular power system successfully

reduced the probability of UPS failure

g) The performance of the ATS is often the limiting factor in achieving higher reliability

18) Summary

a) Understanding how to best define downtime risk is important to optimizing its reliability,

while decreasing TCO and increasing agility

b) While redundancy can in principle increase reliability, there are significant costs and

potentially serious drawbacks

c) Data center professionals need to understand which processes are most critical, and

target reliability accordingly

d) PRA is a powerful tool when applied carefully

Course Assessment: Test Your Knowledge

Course Feedback: We Value Your Opinion

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An Introduction to Medical Gas and Vacuum Systems

Course Outline

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Course Outline

Course Description

This course introduces plumbing and medical gas systems for medical treatment facilities. We will discuss the various types of medical gas and vacuum systems used in health care facilities. The chief purpose of these systems is to provide safe and reliable support to the Codes and standards are also discussed.

Course Objectives

- Discuss the purpose of plumbing and medical gas systems for medical treatment facilities
- Identify the various types of medical gas and vacuum systems used in health care facilities
- Review the important codes and standards used for medical gas and

Course Content or Material

1. Introduction
a. Introduction to Medical Gas and Vacuum Systems
2. Types of medical gas and vacuum systems
a. Medical gas systems
i. Oxygen
ii. Medical Air
iii. Nitrous Oxide
iv. Nitrogen
v. Carbon Dioxide
vi. Mixed Gases
vii. Instrument air
b. Vacuum Systems
c. Medical/Surgical Vacuum
d. Waste Anesthetic Gas Disposal
e. Dental Vacuum Systems (Film will write
3. Codes, standards, regulations and authorities having jurisdiction
a. NFPA 99
b. FGI Guidelines
c. Local or state regulations
d. Enforcement
i. Certificate of occupancy
ii. CMS and accreditation
e. ASSE Standards

4. Categories of medical gas and vacuum systems

a. Introduction to NFPA 99 Categories

b. Category 1

An Introduction to Medical Gas and Vacuum Systems

Course Outline

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c. Category 2

d. Category 3

Course Assessment: Test Your Knowledge

Course Survey: We Value Your Opinion

On Mon, Mar 17, 2025 at 10:39 AM tshingombe fiston <tshingombefiston@gmail.com> wrote:

We will be conducting system maintenance Sunday March 16, 2025 9:00 p.m.-11:00 p.m. EDT. Please note that you will not be able to login at this time.

Course Assessment - Results page

1

2

3

4

5

6

7

8

9

10

Question

A/n _____ measures the amount of electrical current flowing through a circuit during a specific time interval.

Ampere

Volt

Ohm

Watt

Question

Materials with _____ resistance require more voltage to make the electricity flow.

Lower

Higher

Slower

Faster

Question

True or false? The electrical load in a data center is the sum of the various pieces of data center equipment which consume and are supplied with electrical power

T

F

Question

The power in Watts is the _____ power drawn by the equipment, while Volt-Amps is called the _____ power.

Electrical, real

Apparent, real

Real, apparent

Real, solar

Question

A circuit breaker may need to switch short circuit currents as high as _____ times its rated current.

30

15

10

5

Question

Circuit breakers can fail in which of the following ways:

| | |
|---|---|
| Failure to close, or failure to open under fault conditions | |
| | |
| Spurious trip | |
| | |
| Failure to operate with the time-current specifications for the unit | |
| | |
| All of the above | |
| | |
| Question | |
| | |
| This form of standby power uses electromagnetism to produce electricity | |
| | |
| | |

a, Electrochemical generator

Battery

Fuel cell

Mechanical generator

Question

_____ occur when there is a varying quality of connections to the earth at different points in an electrical installation

Ground loops

| | |
|---|---|
| Power factor corrected power supplies | |
| | |
| Ground Fault Circuit Interrupters | |
| | |
| Thermal-magnetic circuit breakers | |
| | |
| Question | |
| | |
| An approach to solve the problem of impulsive transients includes the utilization of which device? | |
| | |
| | |
| | |
| Power Line Conditioners | |

| | |
|---|---|
| Uninterruptible Power Supply (UPS) | |
| | |
| Voltage Surge Suppressor (TVSS) | |
| | |
| Modern harmonic-correction equipment | |
| | |
| Question | |

According to M Technology, Inc., what percentage of the time are circuit breakers involved in a power system failure in data center electrical infrastructure?

10%

40%

70%

50%

Course Assessment - Test

Course Assessment

Number of questions:

10

Questions are shown:

One by one

So far you have done this test 1 time

Previous unit: Online Course

1.4% completed

Lesson Fundamentals of Power

| | |
|---|---|
| Course Overview - Passed | |
| Online Course | |

Course Assessment - Current unit

Reference Materials

Course Transcript

Lesson Going Green: Energy Efficiency in the Data Center

| | |
|---|---|
| Course Overview | |
| | |
| Online Course | |
| | |
| Course Assessment | |

Course Feedback

Reference Materials

Course Transcript

Lesson Building Controls I:
An Introduction to Building Controls

| | |
|---|---|
| Course Overview | |
| | |
| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Combined Heat and Power

Course Overview

| | |
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| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Compressed Air Systems I: An Introduction

Course Overview

| | |
|---|---|
| Online Course | |
| | |
| Course Assessment | |
| | |
| Course Feedback | |
| | |

Reference Materials

Course Transcript

Lesson Energy Efficiency with Building Automation Systems

I

Course Overview

| | |
|---|---|
| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Energy Procurement I: Options in Regulated and Deregulated Markets

Course Overview

| | |
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| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Energy Procurement II: Introduction to Hedging in Deregulated Markets

Course Overview

| | |
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| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Energy Procurement
III: Balanced Hedging
Strategies

Course Overview

| | |
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| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Energy Rate
Structures I: Concepts and
Unit Pricing

Course Overview

| | |
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| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Going Green with Leadership in Energy and Environmental Design

Course Overview

| | |
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| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Maintenance Best Practices for Energy Efficient Facilities

Course Overview

| | |
|---|---|
| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Steam Systems I: Advantages and Basics of Steam

Course Overview

| | |
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| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Lesson Waste Heat Recovery

Course Overview

| | |
|---|---|
| Online Course | |
| | |
| Course Assessment | |

Reference Materials

Course Transcript

Previous unit: Online Course

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16) Calculating Efficiency and Operating Costs

a) The technical design of the modular, scalable system results in a much higher rate running on lightly loaded UPS units

b) The Fortune 500 firm in our case study:

i) Chooses to implement redundant UPS systems and operates each of them at

capacity

ii) Chooses the "install as you grow

differences in energy savings, and

therefore, lower electrical bills

17) Total Cost of Ownership

a) Capital costs

i) Allow for an initial build out of 27 watts

ii) Assume a build-out to 80 watts per

square foot for an additional 5 years

b) Electrical costs

i) Load levels will be at 80% of 2 (N+1)

units

ii) The maximum loading on any one

system is 40%

c) Service costs

i) Customer requires 7x24

ii) 4 hour response

iii) 100% coverage on parts and labor

iv) Battery maintenance will not be

included

18) Key TCO Components of Payback

19) Summary

a) The green data center features a safe

and healthy work environment and

energy efficient manner

b) Five examples of green approaches in

the data center include the proper use of

batteries,

c) TCO analyses can justify investments in

green technologies

Course Assessment: Test Your Knowledge

Course Feedback: We Valu

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Course Description

Power is the foundational cornerstone in the data center. Many instances of downtime, software and data corruption, are the result of a problematic supply of power. It is imperative that servers are insulated against utility power failures, surges, and other electrical problems. This course will explore the topic of power, and how it is center.

Course Outline:

Learning Objectives

- Identify basic electricity concepts
- Describe electrical power and its components
- Differentiate between various power usages in a data center
- Define power factor
- Recognize the importance of electrical efficiency and power factor
- Identify potential problem areas in the data center

Agenda

- Electrical power key terms
- AC and DC power
- Power factor
- Volt configurations, plugs and receptacles
- Circuit breakers and convenience outlets
- Seven common electrical problems
- Components in a data center

Introduction

1) Key Terms

a) Volt (V)

b) Ampere (Amp)

c) Ohm (Ω)

d) Hertz (Hz)

e) Alternating Current (AC)

f) Direct Current (DC)

g) Load

2) Single-phase and 3-phase Power

3) Watts and Volt-Amps

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4) Power Factor Correction

a) Power factor of nearly 1

b) Method of offsetting inefficiencies created by electrical loads

5) Plugs and Receptacles

a) The most common plug/receptacle combination for IT equipment is of an IEC

b) Also common are plugs and receptacles of the twist-lock variety

| | |
|---|---|
| | 6) International Electro-technical Commission Plugs |
| | 7) National Electric Manufacturers Association Plugs |
| | 8) Circuit Breakers |
| | a) A type of switch |
| | b) Designed to protect electrical equipment from damage caused by |
| | c) Designed to trip at a given current level |
| | 9) Circuit Breaker Protection |
| | 10) Circuit Breaker Sizing |
| | 11) GFCI, ELCB, and RCD |
| | a) Ground Fault Circuit Interrupters (GFCI), Earth Leakage Circuit Breakers (ELCB), or Residual-Current Devices (RCD) trip a circuit if they detect a small amount of current |
| | b) Larger data centers use resistor banks instead of GFCI, ELCB, or RCD |
| | 12) Convenience Outlets |
| | a) Used for non-computer devices |
| | b) Allows for other non-computer equipment to be plugged in without |
| | 13) Grounding |
| | a) Safety measure to protect against electric shock |
| | 14) 7 Power Problems |
| | a) Impulsive Transients |
| | b) Interruptions |
| | c) Sags and Undervoltages |
| | d) Swells and Overvoltages |
| | e) Waveform Distortion |
| | f) Voltage Fluctuations |
| | g) Power Frequency Variation |
| | 15) Standby Power and Distribution |
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| | a) Any power source available to the data center that supplies power when utility unavailable |
| | 16) Power Distribution Components |
| | a) Primary power source (Utility) |
| | b) Emergency power source (Generator) |
| | c) Circuit/Branch Circuit |
| | d) Uninterruptible Power Supply (UPS) |
| | e) Automatic Transfer Switch |
| | f) Power Distribution Units (PDU) |
| | g) Outlet Strips |
| | h) Server Plug |
| | 17) Summary |

a) Power infrastructure is critical to uptime

b) Understanding basic power terms helps to better evaluate the interaction utility, standby power equipment, and load

c) Failures can occur at various points in the power infrastructure, but special care given to the condition and coordination of circuit breakers

d) Numerous power anomalies exist that can impact the uptime of data center equipment

e) Understanding the threats and applying practical power solutions can

Course Assessment: Test Your Knowledge

Course Feedback: We Value Your Opinion!

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i. The controlling variable is affected by the actions of the controlled device upon the controlled variable

c. Cascading

i. Used to modify the performance of closed control loops when required

5) Red Wire & Direct Digital Controls

a. DDC

i. More sophisticated system

ii. Use electronic controllers that support multiple control loops

b. Enable / disable control

i. Another form of electronic control

ii. Simply turns another controller on or off

iii. One controller will determine when another controller is able to perform its function

6) Summary

a. For an environmental control system to effectively manage the environment in a building, thereby increasing comfort, efficiency and occupant comfort, three things must take place

i. Data must be measured and provided

ii. Measured data then can be compared to a set of desired outcomes or instructions

iii. An output is produced based on the measured data to change or maintain the environment

b. A simple control loop is defined as one control logic, which provides an output to

c. Inputs and outputs may be analog or digital

d. A controller may contain many control loops, and a control system may contain many controllers

e. There are three types of control loops

i. Open

ii. Closed

iii. Cascading

i. And there are three common control technologies
i. Pneumatic
ii. Electrical, and
iii. Electronic
g. Electronic controls may be
i. Direct Digital Control, called DDC, or
ii. Enable / Disable Control©2023 Schneider Electric. All rights reserved. All

Combined Heat and Power (Cogeneration)

Course Description: Cogeneration today is widely used throughout the world for efficient production of heat and power. Cogeneration is the simultaneous generation of heat and power in a single thermodynamic process. The purpose of this course is to review the different technologies for applying technology to the function of cogeneration. We'll also explore the unique considerations for deployment of the two main types of cogeneration cycle plants (including "Topping Cycle" Combined Cycle plants) and "Bottoming Cycle".

Pre-requisites for this course include: Energy Rate Structures I and II

Learning Objectives:

At the completion of this course, you will be able to:

• Define what cogeneration is along with the primary fuels used in its creation
• Identify the different approaches for applying technology to the function of cogeneration
• Discuss the various factors to consider when evaluating the use of a CHP plant

Course Content or Material

1) Introduction
a) Technology overview
b) Defining "cogeneration"
i) How cogeneration occurs
ii) Primary fuels used
2) Two main approaches for cogeneration technologies
a) Topping Cycle plants (including Combined Cycle plants)
i) Examples
ii) Overview
b) Bottoming Cycle Plants
i) Examples
ii) Overview
3) Environmental Issues
a) Benefits
b) Concerns
4) Things to Consider When Applying CHP Plant

a) Steam load versus electric load
b) Capital utilization / productivity
c) Reliability requirements (steam and electric)
d) Local electricity rates
e) Efficiency gains versus fuel prices
f) Fuel availability and selection
g) Staffing and training
5) Comparing CHP Technologies
a) Diesel engine
b) Natural gas engine
c) Steam Turbine
d) Gas Turbine©2023 Schneider Electric. All rights reserved. All trademarks
Compressed Air Systems I: An Introduction
Course Description
Compressed air is widely used throughout industry. It is sometimes called the "fourth utility" after electricity, gas and water. From mining, lumber and paper mills, petroleum, production to small manufacturing plants and hotels, compressed air provides often represent the majority of the facility energy costs. Since many facilities compressed air, reliability is paramount, but given that sound operating practices consumption by 20% to 50%, efficiency is high on the agenda.
This is the first in a series of compressed air system courses offered by Energy University. In this course we will look at the relative inefficiency of compressed air and examine the air system.
Course Outline
Course Objectives
Objectives
• Explain basic compressed air terms and concepts
• Describe the relative inefficiency of compressed air as a power source
• Define the supply and demand sides of a compressed air system and
• Identify the components of a compressed air system and explain what
Course Content or Material
1) Introduction
2) Supply & Demand
a. Divided into a supply side and a demand side
3) Compressed Air Pros & Cons
4) Compressed Air Inefficiency Examples
a. Metric Unit Example

b. US Customary Unit Example
5) Compressed Air Systems Optimization
a. The efficiency of compressed air
r. systems is often compromised by
plant operations staff
ii. Modifying a system is perceived as a
risk to production
iii. Vendors compete in a market where
equipment is typically sold on "lowest
b. Optimization leads to
i. Reduced costs
ii. Reduced maintenance
iii. Less downtime
iv. Increased production
v. Improved product quality
6) Equipment Descriptions
a. Fan
b. Blower
c. Compressor
7) Pressure Terminology
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a. Pressure
b. Absolute Pressure
c. Gauge Pressure
8) Standard Volume of Air
a. Metric
b. US Customary
9) Volume Flow
a. Inlet flow
b. Actual flow
c. FAD
d. Standard flow
e. Capacity
10) Operating cost
a. Proportional to volume
b. Proportional to pressure ratio
11) Dew Point
a. The temperature at which
condensation begins to occur
12) Compressed Air Requirements
a. Cleanliness
b. Dryness
c. Oil content
13) Compressed Air System Components
a. Interactive element
14) Summary

a. Basic compressed air terms and concepts;

b. Compressed air as a source of power is relatively inefficient. However, it can be useful and necessary at times;

c. Compressed air systems are normally broken down into supply and demand components;

d. You should now be able to identify basic components of a compressed air system and explain what they do©2023 Schneider Electric. All rights reserved.

Energy Efficiency with Building Automation Systems Part 1

Course description:

In this course we will focus on what a building automation system (BAS) is as well as some of the commonly used terminology. We will also look at some of the HVAC strategies used in automation systems.

Course Outline:

Learning objectives

At the completion of this course you will be able to:

• Define what a building automation system is

• Review the main terminology and components of a Building Automation System

HVAC system

• List the most common HVAC strategies that may be controlled by a Building System

Course content or material

1) Introduction

a. What is building automation

b. What are the functions of building automation systems (BAS)

2) Parts of a BAS

3) Terminology

a. Set point

b. Air

4) Review of HVAC systems

a. Equipment

i. Air handling unit

ii. Chiller

iii. Cooling tower

iv. Flow controller

v. Boiler

vi. Dual duct

vii. Constant volume/variable temperature

| | | |
|---|---|---|
| | viii. Variable air volume<br>ix. Terminal reheat©2023 Schneider Electric. All rights reserved. All | |
| | Energy Procurement I<br>Course Description: The procurement of energy (electricity, natural gas, fuel oil, etc.) is becoming a major part of the energy manager's job. Cost effective energy procurement requires an understanding of the market, regulatory limitations and opportunities, and the purpose of this course is to raise awareness of the available options for<br>Learning Objectives:<br>• Define the roles of the main players in the energy value chain<br>• Explain the major differences in related deregulated markets<br>• List the main options available for optimizing energy procurement<br>Course Content or Material:<br>1) Introduction<br>2) Types of Energy Typically Procured<br>a) Most common electricity and natural<br>b) Coal, Oil-based fuels, Steam, Compressed air<br>3) Energy Supply Chain<br>a) Production, Transmission, Distribution, Supply<br>b) Gas supply chain<br>c) Electricity supply chain<br>4) Regulated and deregulated markets<br>a) Regulated Markets<br>b) De-regulated Markets<br>c) Wholesale versus Retail<br>d) Equal access to transmission and distribution<br>e) Drivers of Deregulation<br>f) Pricing<br>i) in a regulated market<br>ii) in a deregulated market<br>g) Options in a regulated market<br>i) Natural gas contracts<br>ii) Power contracts<br>h) Options in a deregulated market<br>i) Supplier Options<br>i) Local distributor<br>ii) Gas or power marketers<br>iii) Brokers<br>iv) LDC Marketing Departments<br>v) Aggregator<br>vi) Power Pool and Exchange Operators<br>vii) Overview of Supplier Options | |

viii) Pipeline Connects for Large Consumers
5) Procurement pitfalls
a) Exposure to energy price volatility that has not been identified or quantified
b) Energy that is managed locally with no corporate oversight
c) Procurement decisions that are made by personnel without knowledge of the market
d) Contracts renewed based on expiration, not market conditions
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e) Contract renewals that embedding the
f) A conviction that hedging is speculative in nature
g) Deregulation Growing and Prices are Volatile

a) Hedging

b) Avoiding pitfalls of lowest price and highest risk©2022 Schneider Electric. All

Energy Procurement II

Course Description: Unprecedented volatility in today's energy markets has
havoc on the profit margins and bottom lines of many industrial companies. In
successfully manage costs in this market, it is critical to apply commodity-based purchasing strategies—or as it is commonly known in the industry: "hedging". Energy price risk management and hedging programs quantify exposure to adverse events and mitigate the impact of those events on financial results. An on-going Energy Risk Management program can provide for more predictable budgeting and insulate earnings from the unpredictable effects of volatile energy prices. The purpose of this course is to address the hedging process. We will also cover the spot and forward markets as well as fixed and index linked contracts.

Pre-requisites: Energy Procurement I: Options in Regulated and Deregulated

Learning Objectives:

At the completion of this course, you will be able to:

- Explain the difference between spot and forward markets
- Describe how hedging reduces your risk and we will be able to
- Define the meaning of fixed and index-linked contracts

Course Content or Material

1) Introduction

a) Brief overview of gas and electricity markets
b) Energy procurement
2) Procurement Pitfalls
a) Common pitfalls in a deregulated market
b) How energy managers remedy common errors in energy procurement
3) Commodity Markets for Energy
a) Commodity exchanges
i. The New York Mercantile Exchange (NYMEX)
ii. The Singapore Commodity Exchange (SICOM)
iii. The former International Petroleum Exchange (IPE) has combined and now part of Intercontinental Exchange (ICE)
iv. Over The Counter
b) Energy buyer options
i. Spot market
ii. Forward market
i. Fixed contract
ii. Index-linked contract
4) Determining Energy Prices
a) Total energy costs
b) Regulated cost components
c) Commodity-based market purchasing strategies
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5) Avoiding Trends of Lowest Price and Highest Risk
a) Define energy purchasing strategy
i) Spot purchasing versus fixed price purchasing
ii) Hedging
6) Implementing Hedging
a) Forward contracts
b) Futures market
c) Flattening a position
d) Trading forward contracts
e) Permutations
f) Contract expiration
g) Imbalances upon delivery
7) Hedging Examples
a) Hedging on the forward market
b) Settling contracts on the spot market
8) Fundamental Concept of Hedging
a) Shaves off the extremes
b) Provides predictability
9) Adopting a Balanced Approach to Hedging
a) Full requirements fixed-price
b) Partial fixed-price
c) Partial spot market

d) Staggered fixed-price commitments©2021 Schneider Electric

Energy Procurement III: Balanced Hedging Strategies

Course Description: Managing energy costs is the key to a successful profit and bottom line for many industrial companies. In order to successfully participate in this market, it is helpful to apply a balanced hedging strategy. A balanced hedging approach will quantify exposure to adverse events and mitigate the impact of these events on financial results. The purpose of this course is to describe a variety of hedging strategies, and identify the main drivers of energy prices. We will also explore commodity market functions to support energy trading.

Pre-requisites: Energy Procurement I and Energy Procurement II

Learning Objectives:

At the completion of this course, you will be able to:

- Describe a variety of balanced hedging strategies
- List the main drivers of energy price
- Describe how commodity markets function to support energy trading

Course Content or Material

1) Adopt a Balanced Hedging Strategy

a) Brief overview of concepts covered in

i) Full requirements fixed-price

ii) Partial fixed-price

iii) Partial spot market

iv) Staggered fixed-price commitments

b) Determination requirements

i) Commitment term

ii) Tolerable price levels

iii) Range of tolerable cost fluctuation and

iv) Minimum/maximum time horizons for making the next commitment

v) Plan of action to mitigate damage for when prices change rapidly

2) Risk Tolerance

a) Definition of hedge ratio

b) Defining risk tolerance

3) Defining a Hedge Ratio and Strategy

a) Riverbanks analogy

b) Examples of hedge ratio and energy purchasing strategies

4) Exchange Operation

a) How commodity exchanges function

b) Commodity exchange regulation

c) Commodity-based market purchasing strategies

5) Terms and Mechanisms

a) The short position – which means you are agreeing to sell

b) The long position – which means you are agreeing to buy

c) The price of the contract

d) The daily account adjustment

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e) The final settle price

f) The strip

g) Futures market versus the stock market

h) Final settle

6) Drivers of Energy Prices

a) Supply

b) Demand

c) Seasonality

d) News and Rumors

e) Speculators

7) Commodity Risk Analysis

a) Role of gas and power marketers

b) Role of independent market analysis service providers

8) The Forward Curve

a) Definition

b) Examples

9) Price Forcasting

a) Definition

b) Examples

10) Other Procurement Considerations

a) Price, dependability and service

b) Importance of considering

11) Best Practices

a) Integrates on a continual basis

i) Data

ii) Risk management

iii) Procurement

b) Employs

i) Data driven decisions

ii) Management approach that identifies and quantifies risk before determining the best way to manage it

iii) Procurement optimisation with operations

12) Summary

10) Summary

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Energy Rate Structures Part 1: Concepts and Unit Pricing

Course description:

Understanding the forms of energy used at a facility, and the rate structure for each, is key to understanding energy costs and implementing an energy efficiency program. By understanding what you are paying for energy, and how the rate structure functions, you can adopt different strategies for reducing your energy costs. You may also be able to move to a different rate structure that is more cost effective for you. In this we will focus primarily on gas and electricity concepts and unit pricing.

Course Outline:

Learning objectives

At the completion of this course you will be able to:

• Define and recognize the difference between consumption and demand

• Identify different forms of energy pricing including

• flat rates, block rates, seasonal pricing, time of use rates, and real time pricing

Course content or material

1) Introduction

a. Understanding different forms of energy

2) Consumption and Demand

a. Difference between consumption and demand

b. Example

3) Energy Pricing

a. Types of energy pricing

i. Flat rate

ii. Block rate

1. Declining

2. Inverted

iii. Seasonal rates

iv. Time-of-Use rates

1. On-peak

2. Off-peak

3. Shoulder/Mid-peak

v. Time of use rates

vi. Real Time Pricing

vii. Other forms of pricing©2023 Schneider Electric. All rights reserved.

Going Green with Leadership in Energy and Environmental Design Course Outline

Course Description:

This course defines green buildings, explains the mission of the US Green

Building Council and the requirements of Environmental Design (LEED) rating

meeting the LEED requirements will also be explained

Course Outline:

Learning Objectives

At the completion of this course, you will be

• Define the characteristics of Green Building

• Explain the mission of the US Green Building Council

• Identify the Leadership in Energy and Environmental Design rating system

• Describe Schneider Electric products and services which satisfy LEED requirements

Agenda

• Introduction

• Impacts of US Buildings on the Environment

• Advantages of building green

• Review the Mission of the US Green Building Council

• Discuss the LEED rating system

• Discuss Schneider Electric products and services that satisfy LEED requirements

• Introduce Case Studies

• Summary

Course Content or Material

1) Introduction

a) Green Building

b) Design of Leadership in Energy and Environmental Design (LEED)

c) Who makes up the LEED team

d) LEED reach

e) Point of the LEED point based system

f) Why is there a demand

2) Impacts of US Buildings on the Environment

a) Impacts of US buildings on resources

b) US Energy Consumption

c) US Electricity Consumption

3) Advantages of Building Green

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a) Demand for Green Building

b) Perceived Business Benefits

c) Predictions in growth of Green

d) Next Generations impact of perceptions of green build

4) Mission of USGBC

a) Mission statement for USGBC

b) What the USGBC does

c) Membership

5) LEED Rating System

a) LEED addresses complete lifecycle of buildings

b) 4 Levels of LEED
c) 6 Credit Categories
d) Steps to LEED Certification
e) A sample checklist
f) Available resources on line
g) Schneider Electric products and services that satisfy LEED requirements
a) Maximizing LEED points
b) Building Automation and Control
c) Critical Power and Cooling
d) Engineering Services
e) Field Services
f) Lighting and Lighting Controls
g) Power monitoring
h) Variable Frequency Drives
i) Renewable Energy Systems
j) Available Solutions for Compliance
7) Case Studies
a) Great River Energy Headquarters
b) Genzyme Center
c) Duke University Smart Home

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Maintenance Best Practices for Energy Efficient Facilities
Course Outline
Course Description
Good maintenance saves energy costs! Properly maintained facilities and equipment run more reliably, produce quality products, reduce downtime and have lower energy costs. This adds up to real savings. This course will address the importance of maintenance in facilities, discuss the maintenance that can contribute, and identify techniques that can lead to the energy maintenance of facilities.
Course Outline
Course Objectives
• List organizational problems that lead to inefficient maintenance
• Identify the characteristics of an effective maintenance system
• List examples of energy efficiency costs caused by insufficient maintenance
• Calculate the energy costs associated with various types of maintenance failure (compressed air, steam, etc)
• Identify simple ways that infrared, vibration analysis, and ultrasonic surveys identifying maintenance needs
Course Content or Material

1) Introduction

2) Organizational problems

i) Common maintenance problem areas

(1) Lack of work order system

(2) Poor reporting of work orders / problems

(3) Poor analysis of work orders – (Pareto analysis)

(4) Inadequate preventative maintenance program

(5) Inadequate maintenance training

(6) Poor control of maintenance efforts

(7) Lack of management attention

3) Characteristics of an effective maintenance system

i) Bring discipline to the maintenance process by ensuring

• Definition of responsibilities

• Adequate training

• Sufficient tools and equipment

• Clear procedures, including evaluation of results, and an emphasis on identifying reinforcing best practices

ii) These systems can be simple, manual inputs from sensors such as differential pressure across filters, equipment temperatures and vibration

iii) In either case, there are basic requirements for a work order system, analysis, generation of maintenance orders, and performance records of

4) Examples of energy efficiency costs

i) Steam leaks

ii) Steam trap failures

iii) Compressed air leaks

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iv) Uninsulated pipes

5) Tables and charts – Calculating the cost

6) Steam Systems

The steam system maintenance should include:

Steam Trap Survey and Repair

Leak Repair

Insulation Repair

7) Compressed Air Systems

i) An efficient compressed Air System must include a regularly scheduled survey for air leaks.

8) Lighting

.

Once your solution is defined, your maintenance program should cover:

(a) Cleaning

(b) Relamping

(c) Monitoring compliance with expectations

(d) Maintaining standard IESNA light levels

9) Motors

a) Use Premium Energy Efficient motors where possible particularly for failed motors

b) Use Variable Speed or Variable Frequency drives

c) Use cogged belts or synchronous belts

i) Properly align motors and drives

(1) Use laser alignment tools for both direct drive and belt drives

(a) This step is crucial to extend motor life.

(f) Design motor bases for easy adjustment

10) Ultrasonic, Infrared and Vibration Analysis

In the last section of this class, let's look at some specific tools and techniques and can be usefully applied to the energy-efficiency maintenance of the systems we discussing

a) Ultrasonic Leak detectors

i) Air leaks

(1) Survey for air leaks during full production periods

ii) Steam Traps

(1) Survey steam traps during winter heating season

iii) Specialty gas leaks – especially for high cost gases – Nitrogen, Argon, Carbon Dioxide

iv) Vacuum system leaks

v) Duct work Leakage– particularly in HVAC and process

vi) HVAC and Clean duct leakage – particularly behind insulation

vii) Can be used in some production leak testing processes

b) Infrared

i) Infrared inspection equipment is widely available and is astonishing cheap

ii) Electrical gear inspection

iii) Insulation hot spots

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iv) Roof inspections – Aerial infrared roof inspection especially identifying leak points / saturated insulation

v) Boiler Lagging / Flue Gas Leaks

(1) Infrared inspection can determine point where the leak starts

c) Vibration Analysis

i) Motors and Bearings

(1) Motor / Drive bases should have a mechanic. Concrete is a cheap method of adding mass

ii) Fans

(1) Always dynamically balance fans in place upon installation. Although fans are balanced at the factory, it is common for fans to become damaged and or out of balance during shipment or installation.

iii) Production machinery

(1) Vibration problems usually have one of three solutions - increase mass of the machinery, increase rigidity of the machinery, or dynamically balance the entire element. Any or all of these methods can be used to reduce or control vibration

iv) Vibration problems once resolved usually cease to be a problem.

v) Large rotating machinery – Often include vibration sensors for continuous monitoring

Course Assessment: Test Your Knowledge

Course Survey: We Value Your Opinion

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Steam Systems I: Advantages and Basics of Steam

Course description:

Steam has come a long way from its traditional associations with locomotives and the Industrial Revolution. Today, it serves as an integral and essential part of modern technology. This course will introduce the benefits of utilizing steam in process and different processes

Course Outline:

Learning objectives

At the completion of this course you will be able to:

- List the advantages of steam
- Describe the formation of steam
- Understand the relationship between pressure, temperature, and energy

Course content or material

1) Introduction

a. Advantages of steam

b. What is steam

c. Definitions

i. Joules

ii. BTUs

iii. Temperature

iv. Saturation

v. Enthalpy
vi. Absolute pressure
vii. Gauge pressure
viii. Differential pressure
ix. Sensible heat
x. Latent heat
xi. Total heat
2) Formation of Steam
a. How steam is created
b. Heat energy transfer
i. Example
c. How a boiler makes steam
3) Relationship between pressure, tem©2022 Schneider Electric. All rights
Waste Heat Recovery
Course Description: Waste heat is present in almost all industries and processes.
Opportunities exist to put this waste heat to use economically in order to reduce the energy consumption in the plant. The purpose of this course is to identify economic waste heat, and the equipment used to recover waste heat. The process for calculating waste heat recovery will also be addressed, along with the factors that influence the feasibility of waste heat recovery.
Learning Objectives:
At the completion of this course, you will be able to:
• List the factors that influence the feasibility of waste heat recovery
• Identify opportunities to recover waste heat, the temperature ranges of heat recovered and the possible uses
• Perform calculations of waste heat recovery
• Categorize and explain the general operation of the main equipment used to recover waste heat
Course Content or Material
1) Introduction
2) Benefits of Waste Heat Recovery
a) Direct benefits
i) Reduced energy consumption
ii) Consequent increase in energy efficiency
b) Indirect benefits
i) Reduction in pollution
ii) Reduction in equipment size
iii) Reduction in auxiliary energy consumption
3) Factors Influencing Waste Heat Recovery Feasibility

a) Sufficient quantity
b) Sufficient quality
c) Used economically
d) Location
e) Availability
f) Compatibility
g) Concerns
h) Limits on heat recovery
4) Waste Heat
a) Quality
i) Dependent upon the temperature of
ii) Economic recovery would depend
upon following factors:
b) Quantity Of Waste Heat
i) Quantity of heat (in kcal) = V x ρ x Cp x
Δt
c) Typical Sources Of Waste Heat
i) Heat in waste gases from industrial
processes (High temperature)
ii) Combustion flue gas (Medium
temperature)
iii) Low temperature heat recovery
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iv) Other sources of waste heat
d) Uses of Waste Heat
i) Waste heat can be put to use
or heat available particularly with relation
to temperature and quantity
ii) Pre heating of combustion air:
iii) Pre heating of boiler feed water:
iv) Vapour Absorption Refrigeration:
v) Pre heating for process requirements:
5) Development Of Waste Heat Recovery
System
a) Compatibility of waste heat quality:
b) Scheduling:
c) Location
6) Waste Heat Recovery Devices
a) Recuperators
b) Economizers
c) Waste heat boilers
d) Heat pumps
e) Regenerators
f) Heat Wheels
g) Heat Pipes
h) Other Waste Heat Recovery Devices
7) Sources and Utilization of Waste Heat
Summary Chart
8) Matrix of Waste Heat Recovery
Devices/Applications
9) Calculating Waste Heat Recovery
a) Overview

| | |
|---|---|
| b) Case Study Examples | |
| 10) Summary | |
| Course Assessment: Test Your Knowledge | |
| | |
| Course Survey: We Value Your<br>Opinionperature, and energy | |
| | |
| | |
| | |
| 4) Summary | |

d) Schneider Electric and LEEDs

8) Summary

4) Summary

7) Summary

5) Summary

e) Micro-turbine

f) Fuel cells

6) Summary Skip to main content

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Learner | tshingombefiston@gmail.com

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Fundamentals of Power Outline

Course Description

Power is the foundational cornerstone in the data center. Many instances of downtime, software and data corruption, are the result of a problematic supply of power. It is imperative that servers are insulated against utility power failures, surges, and electrical problems. This course will explore the topic of power, and how it is

center.

Course Outline:

Learning Objectives

- Identify basic electricity concepts
- Describe electrical power and its
- Differentiate between various power usages in a data center
- Define power factor
- Recognize the importance of electrical
- Identify potential problem areas in the data center

Agenda

| | | |
|---|---|---|
| | • Electrical power key terms<br>• AC and DC power<br>• Power factor<br>• Volt configurations, plugs and receptacles<br>• Circuit breakers and convenience outlets<br>• Seven common electrical problems<br>• Components in a data center<br>Introduction<br>1) Key Terms<br>a) Volt (V)<br>b) Ampere (Amp)<br>c) Ohm (Ω)<br>d) Hertz (Hz)<br>e) Alternating Current (AC)<br>f) Direct Current (DC)<br>g) Load<br>2) Single-phase and 3-phase Power<br>3) Watts and Volt-Amps<br>©2021 Schneider Electric. All rights reserved. All trademarks provided are the<br>4) Power Factor Correction<br>a) Power factor of nearly 1<br>b) Method of offsetting inefficiencies created by electrical loads<br>5) Plugs and Receptacles<br>a) The most common plug/receptacle combination for IT equipment is of an IEC<br>b) Also common are plugs and<br>c) International Electro-technical Commission Plugs<br>d) National Electric Manufacturers Association Plugs<br>8) Circuit Breakers<br>a) A type of switch<br>b) Designed to protect electrical equipment from damage caused by<br>c) Designed to trip at a given current level<br>9) Circuit Breaker Protection<br>10) Circuit Breaker Sizing<br>11) GFCI, ELCB, and RCD<br>a) Ground Fault Circuit Interrupters (GFCI), Earth Leakage Circuit Breakers (ELCB), or Residual-Current Devices (RCD) trip a circuit if they detect a small amount of current<br>b) Larger data centers use resistor banks instead of GFCI, ELCB, or RCD<br>12) Convenience Outlets<br>a) Used for non-computer devices | |

b) Allows for other non-computer equipment to be plugged in without
13) Grounding
a) Safety measure to protect against electric shock
14) 7 Power Problems
a) Impulsive Transients
b) Interruptions
c) Sags and Undervoltages
d) Swells and Overvoltages
e) Waveform Distortion
f) Voltage Fluctuations
g) Power Frequency Variation
15) Standby Power and Distribution
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a) Any power source available to the data center that supplies power when utility unavailable
16) Power Distribution Components
a) Primary power source (Utility)
b) Emergency power source (Generator)
c) Circuit/Branch Circuit
d) Uninterruptible Power Supply (UPS)
e) Automatic Transfer Switch
f) Power Distribution Units (PDU)
g) Outlet Strips
h) Server Plug
17) Summary
a) Power infrastructure is critical to uptime
b) Understanding basic power terms helps to better evaluate the interaction utility, standby power equipment, and load
c) Failures can occur at various points in the power infrastructure, but special care given to the condition and coordination of circuit breakers
d) Numerous power anomalies exist that can impact the uptime of data center equipment
e) Understanding the threats and applying practical power solutions can
Course Assessment: Test Your Knowledge

Course Feedback: We Value Your Opinion

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Course catalog

System Maintenance: Sunday March 3/16
Time: 9pm-11pm EDT

We will be conducting system maintenance Sunday March 16, 2025 9:00 p.m.-11:00 p.m. EDT. Please note that you will not be able to login at this time.

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By Language / English

A Comparison of AC and DC Power Distribution in the Data Center (DC0014EN)

Course rating is
4.559724828017511 stars

By Language / English

A Four-Step Path to a Comprehensive Energy Management Action Plan

Course rating is
4.49519890260631 stars

Uncategorized

Abbott Laboratories Energy Efficiency Development Path

Course rating is
4.434782608695652 stars

By Language / English

Accor Energy Awareness Modules

Course rating is
4.595744680851064 stars

By Language / English

Active Energy Efficiency Using
Speed Control

Course rating is
4.63265306122449 stars

By Language / English

AI-Driven Data Centers:
Revolutionizing
Decarbonization Strategies

Course rating is
4.535714285714286 stars

By Language / German

Aktive Energieeffizienz durch
Drehzahlregelung

Course rating is
4.571428571428571 stars

By Language / English

Allergan-GENIUS Team Lead
Advanced Training

Course rating is
4.666666666666667 stars

By Language / English

Allergan-GENIUS Team Lead
Basic Training

Course rating is 4.625 stars

By Language / English

Allergan-Site Energy Team Member Training

Course rating is
4.954545454545454 stars

By Language / English

Alternative Power Generation Technologies (DC0003EN)

Course rating is
4.5764944275582575 stars

By Language / English

American Hotel & Lodging
Educational Institute

Course rating is
4.866666666666666 stars

By Language / English

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| An Introduction to Medical Gas and Vacuum Systems (HC0015) | |
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| Healthcare | |
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Course rating is
4.6521739130434785 stars

By Language / English

An Overview of Data Center Physical Infrastructure (DC0004EN)

Course rating is
4.717684377478192 stars

By Language / French

Analyse financière des projets
I

Course rating is
4.607843137254902 stars

By Language / English

Analyzing Reliability in the Data Center (DC0005EN)

Course rating is
4.670731707317073 stars

By Language / Brazilian Portuguese

Análise Financeira de Projetos I

Course rating is
4.655737704918033 stars

By Language / Spanish

Aplicación de las normas de seguridad - AEA Standards (YT00014SP)

Course rating is 4.8 stars

By Language / Spanish

Aplicación de las normas de seguridad: México (YT00032ES)

Course rating is 4 stars

By Language / Brazilian Portuguese

Aplicando regras de segurança (YT00026BP)

Course rating is 5 stars

By Language / French

Application des règles de sécurité (YT00022FR)

Course rating is 5 stars

By Language / English

Applying Safety Rules (YT00001EN)

Student

Course rating is
4.764444444444444 stars

By Language / French

Approvisionnement en énergie I

Course rating is
4.295454545454546 stars

By Language / French

Approvisionnement en énergie II

Course rating is
4.636363636363637 stars

By Language / Spanish

Aprender los fundamentos de la electricidad (YT00019ES)

Course rating is
4.631578947368421 stars

Course Catalog

College of Data Center

College of Energy Efficiency

Youth Impact Through Learning

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7.1 Appendix A: Summary of applicable MTLx541A/AS, MTLx544A/AS Modules 10 - 12

Analogue Input Modules with passive input

for 4-wire transmitters

Hardware Fault Tolerance

(HFT) †

Module type 0, 1

MTL4541A,

MTL4541AS,

| |
|---|
| MTL5541A, |
| MTL5541AS, |
| MTL4544A, |
| MTL4544AS, |
| MTL5544A, |
| MTL5544AS |
| † These modules have an inherent fault tolerance of 0. |
| SIL |
| IEC 61508:2010 |
| 2 |
| 3SM4541A/AS, 5541A/AS, 4544A/AS, 5544A/AS rev 2 |

# 1 INTRODUCTION

## 1.1 Application and function

The Analogue Input module types
MTLx541A/MTLx541AS (single channel)
and MTLx544A/MTLx544AS

(dual channel) are intrinsic safety
isolators that interface with process
measurement transmitters located in

a hazardous area of a process plant. They are also designed and assessed according to IEC 61508 for use in

safety instrumented systems up to SIL 2.

The MTLx541A provides an input for a separately-powered 4/20mA transmitter located in a hazardous

area, and repeats the transmitter current into a load in the safe area. The MTLx544A supports two identical channels for use with two separate transmitters. The MTLx541AS and MTLx544AS versions act as a current

sink for the safe area connection rather than driving the current into the load.

All the modules allow bi–directional transmission of HART communication signals superimposed on the

4/20mA loop current, so that the transmitter can be interrogated either from the operator station or by a hand-

held communicator (HHC).

There are no configuration switches or operator controls to be set on the modules. These modules are

members of the MTL4500 and MTL5500 range of products.

1.2 Variant Description

Functionally the MTL4500 and MTL5500 range of modules are the same but differ in the following way:

- the MTL4500 modules are designed for backplane mounted applications

- the MTL5500 modules are designed for DIN-rail mounting.

In both models the hazardous area field-wiring connections (terminals 1,2, and optionally 4,5) are made through

the removable blue connectors, but the safe area and power connections for the MTL454xA/MTL454xAS

modules are made through the connector on the base, while the MTL554xA/MTL554xAS modules use the

removable grey connectors on the top and side of the module.

Note that the safe-area connection terminal numbers differ between the backplane and the DIN-rail

mounting models.

The analogue input models covered by this manual are:

| Module type | Number of channels | Safe area connection |
|---|---|---|
| MTL4541A and 5541A | 1 | Current source |
| MTL4541AS and 5541AS | 1 | Current sink |
| MTL4544A and 5544A | 2 | Current source |
| MTL4544AS and 5544AS | 2 | Current sink |

Note: To avoid repetition, further use of MTLx54xA and MTLx54xAS in this document can be understood to include both DIN-rail and backplane models. Individual model numbers will be used only where there is a need to distinguish between them.

All the module types described in this manual have the same connectivity for the field signals, supporting 4-wire process transmitters or currents sourced in the hazardous area. The connection of the repeated current

signals into the input measurement channels for the safety logic system follows the arrangement shown in the following diagram. When the input channels of the Safety Instrumented System (SIS) are providing power for

the loop, the ‘S’ variants of the isolator modules are used to ‘sink’ the measuring current.

In the other cases the isolator modules ‘source’ the measuring current that flows into a load resistor inside the

input card of the Safety Instrumented System.

4SM4541A/AS, 5541A/AS, 4544A/AS,
5544A/AS rev 2

2+

1-

Pwr

0V

24V

Safety Instrumented

System (SIS)

Logic Solver with ‘Passive’

input

MTLx541A/

MTLx544A

(Safe area current source)

B

A

2+

1-

Pwr

0V

24V

Safety Instrumented

System (SIS)

Logic Solver with 2-wire input

A

B

Current

limiter

Output

terminal

MTL4541A,

MTL4541AS

MTL5541A, MTL5541AS

A 8 11

B 9 12

4-wire

Transmitter or

current source

Pwr

Field wiring

MTLx541AS/MTLx544AS

(Safe area current sink)

Figure 1.1 – Input and output connections

## 1.3 Product build revisions covered by this manual

The information provided in this manual is valid for the product build revisions listed in the following table:

| Model Type Product build revision covered by this manual |
| --- |
| MTL4541A Up to and including 08 |
| MTL4541AS Up to and including 08 |

| |
|---|
| MTL5541A Up to and including 08 |
| |
| MTL5541AS Up to and including 08 |
| |
| MTL4544A Up to and including 08 |
| |
| MTL4544AS Up to and including 08 |
| |
| MTL5544A Up to and including 08 |
| |
| MTL5544AS Up to and including 08 |
| |

The product build revision is identified by the field ‘CC’ in the module Product Identification Number that

appears at the bottom left-hand corner of the side label:

The CC field immediately precedes the 7-digit Serial Number field, DDDDDDD. Example:

| |
|---|
| 5SM4541A/AS, 5541A/AS, 4544A/AS,<br>5544A/AS rev 2 |
| |
| 2 System configuration |
| |
| An MTLx54x module may be used in single-channel (1oo1) safety functions up to SIL 2. The worked example in this manual is for a SIL 2 application. |
| |

The figure below shows the system configuration and specifies detailed interfaces to the safety-related and

non safety-related system components. It does not aim to show all details of the internal module structure,

but is intended to support understanding for the application.

Figure 2 – System Configuration

The MTLx54xA/MTLx54xAS modules are designed to receive an active 4-20mA signal from separately

powered process transmitters in the hazardous area and to repeat the current flowing in the field loop to the

safe-area load. The shaded area indicates the safety-related system connection, while the power supply con-

nections are not safety-related. The term ‘Logic Solver’ has been used to denote the safety system performing

the monitoring function of the process loop variable.

Note: When using the MTLx544A/MTLx544AS dual-channel modules, it is not appropriate for both channels

to be used in the same loop, or the same safety function, as this creates concerns regarding common-cause

failures. Consideration must also be given to the effect of common-cause failures when both loops of a dual-

channel module are used for different safety functions.

Hazardous area Safe area

Logic Solver

(Safety

related)

Logic Solver

(Safety

related)

| |
|---|
| Power supply |
| |
| (Not safety |
| |
| related) |
| |
| MTL5544A/MTL5544AS (2-channel version) shown. |
| |
| MTL5541A/MTL5541AS (single-channel version) omits Ch 2. |
| |
| 20 - 35V dc |
| |
| 6SM4541A/AS, 5541A/AS, 4544A/AS, 5544A/AS rev 2 |
| |
| 2.1 Associated System Components |
| |

There are many parallels between the loop components that must be assessed for intrinsic safety as well as

functional safety. In both situations the contribution of each part is considered in relation to the whole.

The MTLx54xA/MTLx54xAS modules are components in the signal path between safety-related process transmitters and safety-related control systems. The transmitter or other field device must be suitable for the process

and have been assessed and independently verified for use in functional safety applications.

The field instrument and Analogue input card of the Logic Solver shall have a normal operating range of 4-20mA

but be capable of working over an extended range of 3 to 22mA for under- and over-range. The Logic Solver shall

have the ability to detect and annunciate input currents higher than the threshold of 21mA and lower than the

threshold of 3.6mA to determine out-of-range conditions.

Note that the transmission of HART data is not considered as part of the safety function and is excluded from

this analysis. However, for HART data communication to take place, the input impedance of the receiving equip-

ment must be at least 240R.

3 Selection of product and implications

The safe area output signal from the MTLx541A/AS and MTLx544A/AS modules is within the operating range of

4-20mA under normal conditions. If the field wiring to the transmitter or connection between the isolator and logic solver is open-circuit then the loop current will fall to less than 3.6mA and close to zero. If the field wiring connection

between the transmitter and isolator is short-circuited, the loop current will also fall to below 3.6mA.

For module types MTLx541A and MTLx544A that source the 4-20mA signal in the safe area circuit, then the current

| | |
|---|---|
| | seen by the logic solver will fall to less than 3.6mA and close to zero if the connection between the isolator and logic |
| | solver is shorted. |
| | For module types MTLx541AS and MTLx544AS that sink the 4-20mA signal in the safe area circuit, then the current |

seen by the logic solver will rise to a value greater than 21mA if the connection between the isolator and logic solver

is shorted.

In both cases, the fault condition must be detected by the logic solver in Functional Safety applications. This should

also include the detection of power supply failures which cause the output of the isolator to fall to zero mA.

## 4 Assessment of Functional Safety

### 4.1 Hardware Safety Integrity

The hardware assessment shows that MTLx541A/MTLx541AS and MTLx544A/MTLx544AS modules:

| |
|---|
| • have a hardware fault tolerance (HFT) of 0 |
| |
| • are classified as Type A devices (“non-complex” component with well-defined failure modes) |
| |
| • have no internal diagnostic elements |
| |
| The failure rates of these modules at an ambient temperature of 45°C are as follows: |

| Failure mode | |
|---|---|
| Failure rate (FIT)* | |
| MTL4541A | |
| MTL5541A | |
| MTL4541AS | |
| MTL5541AS | |
| MTL4544A | |
| MTL5544A | |
| MTL4544AS | |
| MTL5544AS | |
| Output current >21mA (upscale) 3 3 3 14 | |
| Output current <3.6mA (downscale) 224<br>224 264 253 | |

Output current within range but >2% in error 42 42 49 49

Output current correct within ±2% 73 73 80 81

*(FITs means failures per 109 hours or failures per thousand million hours)

• Reliability data for this analysis is taken from IEC TR 62380:2004 Reliability Data Handbook.

• Failure mode distributions are taken principally from IEC 62061:2005 Safety of Machinery.

• Stated failure rates for dual-channel modules apply to a single channel.

It is assumed that the module is powered from a nominal 24V dc supply and operating at a maximum ambient

| | |
|---|---|
| | temperature of 45°C. |
| | |
| | 7SM4541A/AS, 5541A/AS, 4544A/AS,<br>5544A/AS rev 2 |
| | |
| | 4.2 Systematic Safety Integrity |
| | |
| | The MTLx54x modules have a systematic safety integrity measure of SC 2. This has been established using |
| | |

compliance Route 1S, as described in IEC 61508-2: 2010, section 7.4.2.2 c.

4.3 SIL Capability

Considering both the hardware safety integrity and the systematic capability, this allows the modules to be

used in safety functions up to SIL 2 in a simplex architecture (HFT=0), provided SFF ≥60% is the case for the

application. The hardware safety integrity assessment has been conducted according to compliance Route 1H,

as described in IEC 61508-2:2010, section 7.4.4. (See example below).

Note:

• Independent of hardware architecture and systematic capability considerations, the hardware probability of

failure for the entire safety function needs to be calculated for the application to ensure the required PFH (for a

high or continuous demand safety function) or PFDAVG (for a low demand safety function) for the SIL is met.

4.4 Example of use in a safety function

In this example, the application context is assumed to be:

• the safety function is to repeat current within ±2%

| | |
|---|---|
| | • the logic solver will diagnose currents above 21mA and below 3.6mA as faults and take appropriate |
| | action |
| | The failure modes shown above can then be defined as: |
| | Failure mode Category |
| | Output current >21mA (upscale)<br>Dangerous detected, dd |

| | |
|---|---|
| Output current <3.6mA (downscale)<br>Dangerous detected, dd | |
| Output current within range but >2% in error Dangerous undetected, du | |
| Output current correct within ±2% No effect, ne* | |
| The failure rates of the MTL4541A and MTL5541A for these categories are then (FITs): | |
| Model sd su dd du ne* | |

MTL4541A or MTL5541A 0 0 227 42 73

In this example, the safe failure fraction (SFF) is 84.4%.

* ne is not used in the calculation of SFF. Defining the “output current correct within ±2%” failure mode as

ne represents a conservative approach to the calculation of SFF. Interpreting this failure mode as su (safe,

undetected) may also be considered and yields an SFF value of 87.7%.

Accordingly, the SFF of all module types described in this manual, when used in the same application,

are as follows:

Model sd su dd du ne SFF

MTL4541A, MTL5541A, MTL4541AS,

MTL5541AS 0 0 227 42 73 84.4%

MTL4544A, MTL5544A 0 0 267 49 80
84.5%

MTL5544AS, MTL5544AS 0 0 267 49 81
84.5%

8SM4541A/AS, 5541A/AS, 4544A/AS,
5544A/AS rev 2

4.5 EMC

The MTL4500 and MTL5500 modules are designed for operation in normal industrial electromagnetic environment but, to support good practice, modules should be mounted without being subjected to undue conducted

| |
|---|
| or radiated interference, see Appendix A for applicable standards and levels. |
| |
| 4.6 Environmental |
| |
| The MTL4500 and MTL5500 modules operate over the temperature range from -20°C to +60°C, and at up to |
| |
| 95% non-condensing relative humidity. |
| |

The modules are intended to be mounted in a normal industrial environment without excessive vibration, as specified for the MTL4500 & MTL5500 product ranges. See Appendix A for applicable standards and levels.

| |
|---|
| Continued reliable operation will be assured if the exposure to temperature and vibration are within the values |
| |
| 3- Auxiliary Powers Systems |
| |
| 4- Passenger Stations |
| |
| 5- eBus Depots |
| |
| 6- Tunnel Systems |
| |
| 7- Depots and Workshops |
| |
| 8- Control Center |
| |

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and Urban Transportation Market

SECTION 4 – Design Considerations

SECTION 5 – Customer Stories

The objective of this section is to:

- Introduce traction substations
- Review EcoStruxure Power value propositions and the associated applications for traction substations
- Provide reference electrical and digital architectures

EcoStruxure Power

Digital Solutions and Services

for:

à Traction Substations

Reference Guide

EcoStruxure Power for

Railway and Urban Transportation

Public

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and Services across the Facilities

SECTION 2 – How EcoStruxure Power

Can Support the Railway Industry

1- Overhead Lines

2- Traction Substations

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What is it?

Introduction to Traction Substations

• Electrical Traction Substations are responsible for supplying trains with electrical energy.

• These facilities manage approximately 75% of the electricity consumption of the entire railway system

• They have a direct impact on the reliability and punctuality of railway traffic.

SECTION 3 – Digital Solutions

and Services across the Facilities

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How does it work?

Introduction to Traction Substations

Energy incomers Traction

transformers

Feeders

Auxiliary

systems

The Traction Substations are located at regular intervals (depending on AC or DC systems) along the railway.

Their main elements are energy incomers, traction transformers, rectifiers (for DC only), feeders and auxiliary systems.

Traction transformers and rectifiers

(the latter for DC configurations) convert

electrical parameters to the energy input

needs of the traction system.

Auxiliary systems

are necessary

for the operation

of the facility.

Feeders provide

energy to the

overhead line

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Two types of traction substations,
depending on the type of traction

Introduction to Traction Substations

Overhead

Line

Railway

25kV

It is most common in Urban
Transportation.

è Catenary supply voltage = 600V- 3.3kV

Railway Urban Transportation

| |
|---|
| Overhead |
| |
| Line |
| |
| Railway |
| |
| 3.3kV |
| |
| 0.6kV |
| |
| ~ |
| |
| Type 1: Alternating Current Supply Type 2: Direct Current Supply |
| |
| Traction |
| |
| Transformer |
| |
| Overhead |
| |
| Line |
| |
| Railway |
| |
| 25kV |
| |
| 50kV |
| |
| Feeder |
| |
| Energy Flow |
| |

This is most common in Railway.

è Catenary supply voltage = usually 25kV, sometimes 15kV

è Two electrical configurations, depending on the number of phases

in the secondary of the traction transformer:

- 1x25 kV
- 2x25 kV

Comparison of Current Supplies

Public

Direct Current (DC)Alternating Current (AC)

Supply

The overhead line is supplied with AC

current with the following configuration:

• Single phase connected to the

overhead line

• Current returns through a return path

Advantages

• Simple configuration. No need of

intermediate transformer stations

• No need of feeder cable

Supply

The overhead line is supplied with AC current with

the following configuration:

• One phase connected to the overhead

| |
|---|
| • The other phase connected to a feeder |
| |
| conductor |
| |
| Phases are 180 degrees out of phase |
| |
| resulting in voltage up to 50 kV voltage. |
| |
| Advantages |
| |
| • Higher energy capacity |
| |
| • Fewer traction substations needed |
| |
| (but requires more simple intermediate |
| |

| |
|---|
| transformer stations) |
| |
| • Reduced electromagnetic interferences |
| |
| Single-phase System (1x25 kV) Two-phase System (2x25 kV) |
| |
| Main Application |
| |
| Urban transportation: metro, light rail, tramways |
| |
| Catenary supply voltage |
| |
| 600V- 3.3kV |
| |
| Supply |
| |

The traction system provides DC current to the

overhead line.

The conversion to direct current requires the use of:

- Non-linear power electronic components

(rectifiers),

- Three-winding voltage transformers

- Medium voltage feeder panels

• Electric protections specially adapted to this mode

Advantages

• Possibility to power a section with two sources

in parallel

• Large installed base, making extensions easier

if the rest of the line also uses DC current

| |
|---|
| • Better regulation of motor speed (before the |
| advent of power electronics) |
| Main Application |
| Mainlines, high-speed lines |
| Catenary supply voltage |
| Usually 25kV, sometimes 15kV |
| Comparison of Current Supplies |

Depending on the installation, the overhead line is powered with a Direct Current (DC) or Alternating Current (AC) system.

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Main components of the electrical architecture

Introduction to Traction Substations

Type 1: Alternating Current Supply Type 2: Direct Current Supply

Type 1 Substation

(Majorly used in Railway)

| |
|---|
| It demonstrates an alternating current (AC) |
| |
| design in a single/two-phase configuration, with |
| |
| an Intelligent Electronic Devices (IEDs)-based |
| |
| control system. |
| |
| Type 2 Substation |
| |
| (Majorly used in Urban Transportation) |
| |

It demonstrates direct current (DC) design with a

PLC-based control system.

Public Main Components for Type 1 Alternating Current Supply Traction Substations

Public Main Components for Type 2 DC Current Supply Traction Substations

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2. Operational Management

Real-time monitoring and control of power system status and

identification of abnormal temperature, insulation faults,

power disturbances, etc.

The Power System Simulation Engine helps train operators

and simulate the effects of switching or maintenance

operations before the actual operation is performed

3. Analysis & Optimization

• Cloud-based predictive power asset maintenance with

expert recommendation provided by our Schneider

Electric service experts

| |
|---|
| • Consulting Services including network and power quality |
| |
| audits |
| |
| • Augmented reality guidance for complicated or rarely |
| |
| 1. Primary Equipment |
| |
| Protection, control, metering, UPS and other equipment used |
| |

in Traction Substations. These are described in more detail in

the following pages

EcoStruxure Power Value Proposition

Apps,

analytics,

and services

Edge

Control

Connected

products

for Traction Substations

| |
|---|
| Cloud-Based Advisor Services for asset management, data integrity |
| |
| and workforce empowerment with extended reality guidance |
| |
| Power quality |
| meter |
| |
| Protection |
| |
| relay |
| |
| Circuit |
| |
| breaker |
| |
| Control |
| |
| unit |
| |
| Cooling |
| |
| DC protection |
| |
| relay |

| |
|---|
| (Third party) |
| |
| Gateway |
| |
| UPS Protection |
| |
| device |
| |
| Panel |
| |
| server |
| |
| Power |
| |
| quality |
| |
| solutions |
| |
| AVEVA |
| System Platform |
| |
| EcoStruxure |
| |
| Power Automation |
| |
| System |
| |
| EcoStruxure |
| |
| Power Operation / |
| |

Power Monitoring Expert Simulation Engine

Our solution to control and supply energy to traction substations

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Specific pillars for traction substations

EcoStruxure Power Value Proposition

EcoStruxure Power provides applications
to support the challenges of Traction
Substations for Railway

| |
|---|
| and Urban Transportation, with the following pillars: |
| |
| Reliable |
| |
| Electrification |
| |
| Electrical Distribution |
| |
| Monitoring and Alarming |
| |
| Capacity Management |
| |
| Power Event Analysis |
| |
| Power Quality Monitoring, |
| |
| Correction, and Compliance |
| |

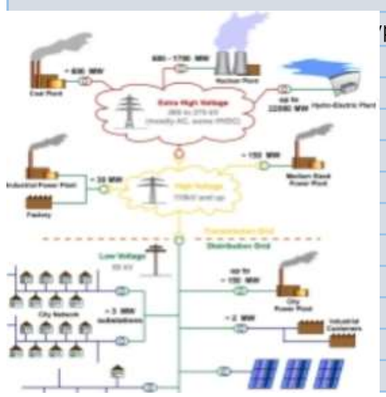
| |
|---|
| Advanced Protection and Automation |
| |
| Safety and Comfort |
| |
| Enhance safety and comfort in |
| |
| passenger stations and tunnels |
| |
| Continuous Thermal Monitoring |
| |
| Guided Procedures Through |
| |
| Extended Reality |
| |
| Digitalization |
| |
| Operate centrally and |
| |

maintain infrastructure efficiently

Backup Power Testing

Circuit Breaker Settings Monitoring

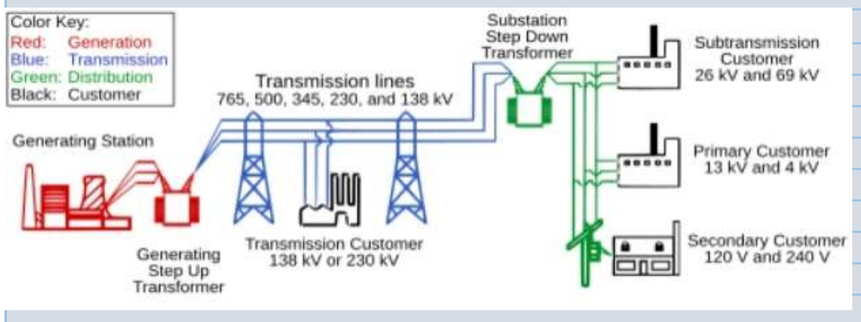
encyclopedia




ypes of generators and loads; generators must be

ways that led to separate companies handling transmission and distribution.[2]

System



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| | Middle Chapters | | |
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| | , Chapter Structures | | |
| | | | |
| | , Materials and Methods | | |
| | | | |
| | , Investigative Theories | | |
| | Results, | | |
| | Discussions, | | |
| | Conclusions, | | |
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| | Bibliography, | | |
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| | Appendices | | |
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|---|---|---|---|
| | 3.4.1. PROPOSAL OF THESIS CONTENT AND/OR FINAL PROJECT | | |
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| | This will show you the steps to submit the content of your Thesis or Final Project to our | | |
| | | | |
| | Academic Staff. We recommend you follow the thesis recommendations on the | | |
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|---|---|---|---|
| | following pages, that at a declarative level, but not be limited to, can contain: | | |
| | | | |
| | • NAME OF THE THESIS (title page) | | |
| | | | |
| | • INDEX | | |
| | | | |
| | • INTRODUCTION | | |
| | • DESCRIPTION | | |
| | | | |
| | • GENERAL ANALYSIS | | |
| | | | |
| | • CURRENT INFORMATION | | |
| | | | |
| | • DISCUSSIONS | | |
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|---|---|---|---|
| | • CONCLUSIONS | | |
| | | | |
| | • BIBLIOGRAPHY | | |
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| | 3.4.2. FINAL THESIS OUTLINE | | |
| | | | |
| | Below you will find two outlines to help you with your thesis. The first one is less detailed than the second one, but both provide a general outline with guidelines to direct | | |
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| | you to write a successful thesis: | | |
| | | | |
| | Thesis Outline #1 | | |
| | | | |
| | Acknowledgements (to people who helped you) | | |
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| | Abstract (a short summary of your thesis) | | |
| | | | |
| | Chapter 1: General Introduction | | |
| | | | |
| | Contextual Data | | |
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| | Background Information | | |
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| | Chapter 2: Definition of the Investigation (or Issue) | | |

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| | Statement of the Issue | | |
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| | Description of the Issue | | |
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| | Chapter 3: Dynamics of the Anticipated Solution | | |
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| | Goal(s) and Objective(s) of the Investigation | | |
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| | Methodology | | |
| | | | |
| | Chapter 4: Overall Outcomes | | |
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| | Strategy and Techniques | | |
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| | Results | | |
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| | Chapter 5: Analysis | | |

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| | Interpretation of Results | | |
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| | Questions about alternatives | | |
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| | Chapter 6: Conclusion | | |
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| | General Discussions | | |
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| | Recommendations | | |
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| | References | | |
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| | Appendices | | |
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| | While the above outline may be modified, it is highly recommended that you use the | | |
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| | outline, though you should change, add, or remove wherever you find it appropriate. | | |
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| | 240 | | |
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| | Thesis Outline #2 | | |
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| | I. Introduction | | |
| | • Definition of the notion/concept of modernity (an explanation of the key term) | | |
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| | • Introduction of the topic (what specific topic will be featured?) | | |
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| | • The issue being debated (what specific aspect of the topic will be considered?) | | |
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| | II. Elements of procedures | | |
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| | • Presentation of the methodology (the modalities of the debate) | | |
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| | • Choice of the variables (an overview of ways data will be manipulated) | | |
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| | • Possible Outcomes (a hypothesis) | | |
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| | III. Review of the Literature | | |
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| | • Past Literature (what old authors have said on the topic?) | | |
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| | • Modern Literature (what contemporary authors have said on the topic?) | | |
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| | • A Comparative Reading (a possible comparison of the two) | | |
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| | IV. Detailed Analysis | | |
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| | • The Actual Process | | |
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| | • Illustrations | | |
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| | • Preliminary Results | | |
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| | V. Overall Outcomes | | |
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| | • The Actual Results | | |
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| | • Interpretations of Results | | |
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| | • Link to Real Life | | |
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| | VI. Analysis | | |
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| | • Isolated Analysis | | |
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| | • Comparative Analysis | | |
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| | • Questions about alternatives | | |
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| | VII. Conclusion | | |
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| | • General Discussions | | |
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| | • Recommendations | | |

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What are S1, S2,and S3 in the LH4N2 wiring diagram?

**Issue:**

S1, S2 and S3 buttons wiring diagram indication in LH4N2.

**Product Line:**

LH4N

**Environment:**

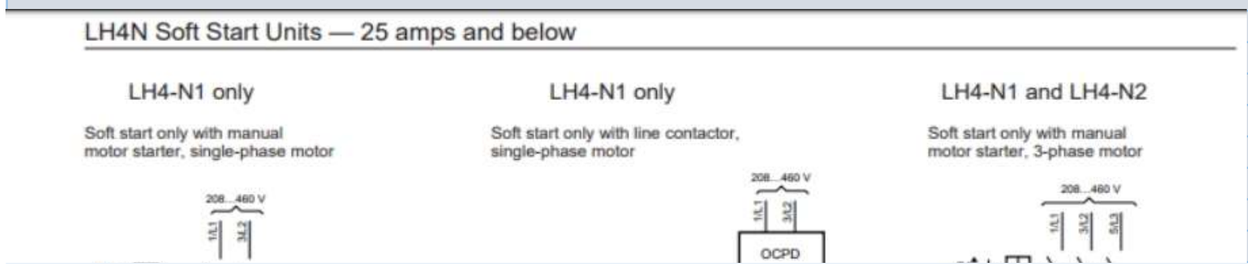
All

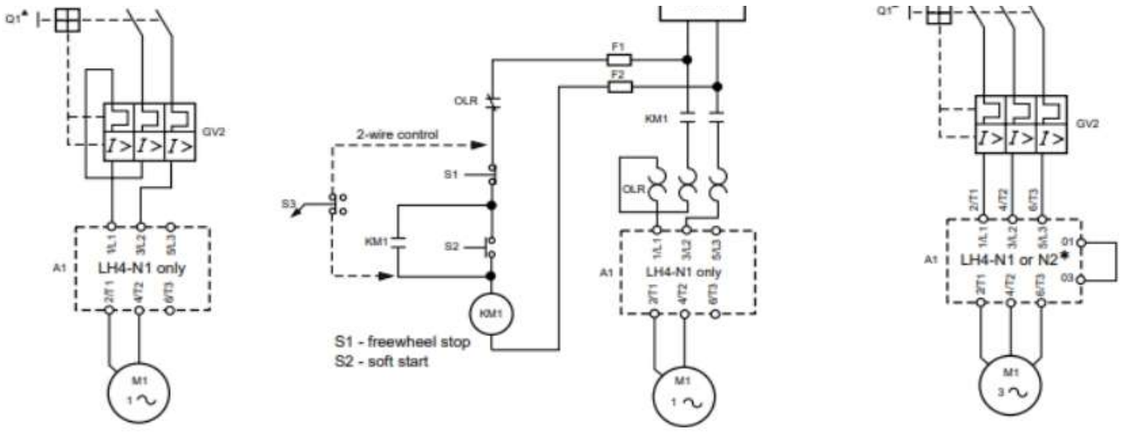
Cause:

**Control wiring circuit**

**Resolution:**

The S1, S2, and S3 are switch designations in the recommended wiring schemes. When these switches are wired as indicated the S1 is for freewheel stop operation, S2 is for soft start operation FWD, and S3 is for soft start REV.

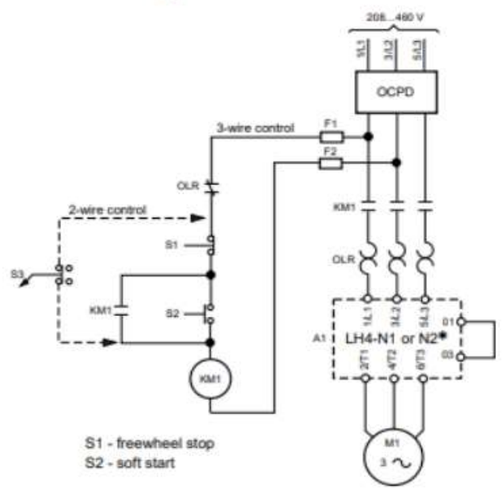





▲ When using manual motor controller (GV2) overcurrent protection must be provided in accordance with applicable installation code.

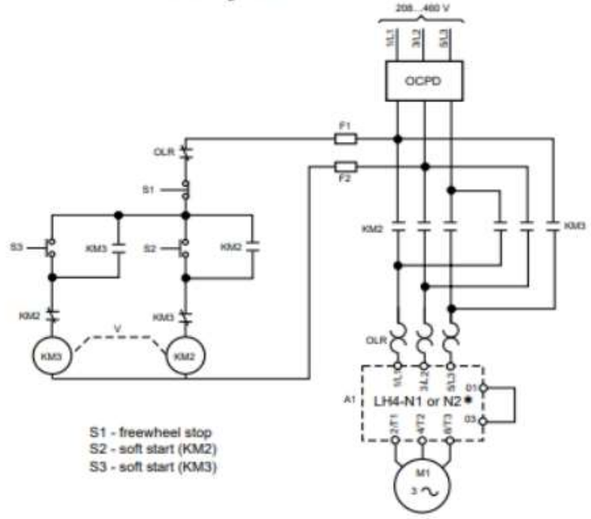
LH4-N1 and LH4-N2

Soft start only with line contactor, 3-phase motor




LH4-N1 and LH4-N2

Soft start only with line contactor, reversing motor




✱ NOTE: On LH4-N2 units, connection from terminal 01 to 03 is required for soft start ramp. Connection is not required on LH4-N1 devices.

Released for:Schneider Electric South Africa

**Attachment(s)**

LH4N Soft Starter Installation Manual.pdf [143.1 KB]

Published on:2006/11/07Last Modified on:2022/04/01

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93% of people found this helpful

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Explanation of Voltage and Current Input Wiring Diagram for ION8650/8600 Form 35 and 35S, 4-Wire WYE, 2 PTs, 3 CTs

**Issue**

When the ION8650 is set to 35 or 35S, 4-Wire WYE, 2 PTs, 3 CTs, the meter does not seem to read correctly.

**Product Line**

ION8650

ION8600

**Environment**

System Setup

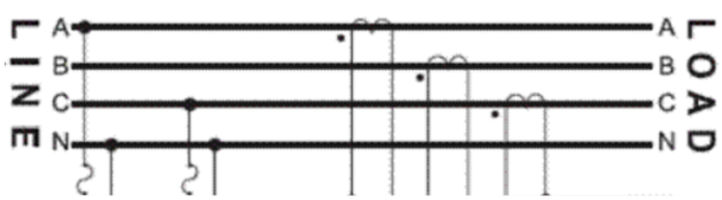
**Resolution**

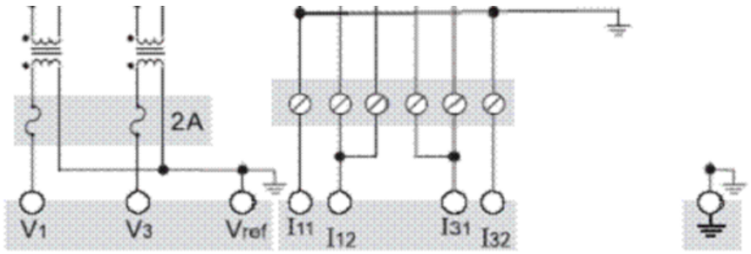
*****This configuration can affect some of the meters parameter calculations. Contact Schneider Electric for details.*****

This configuration will work for measuring total power. When an ION8650/8600 series meter is applied in this way, some of the many parameters that are provided appear to be calculated incorrectly because of the

**Please note: The following setup does not work for unbalanced systems.**

Form 35S, 4-Wire Wye, 2 PTs, 3 CTs






**1. Phase to Neutral Voltages**

Will not be displayed, because DELTA mode does not display line-to-neutral voltages.

**2. Phase to Phase Voltages**

Vab and Vbc will display **phase to neutral voltages**. Vca will correctly show the phase-to-phase voltage. Vll avg will be incorrect.

**3. Current**

Since the CT secondary windings are delta connected, the displayed Ib value is ?(3) * ?(3) or 3 times larger than Ia and Ic. Where Ia = ?(3)I1 AND Ic = ?(3)I3 and the I1 and I3 are currents in the primary.

**4. Real Power**

The kW total will be correct.

**5. Reactive Power**

The kVAr total will be correct.

**6. Apparent Power**

The kVA total will be correct.

**7. Power Factor**

The PF total will be correct.

**Summary for Delta Mode:**

| Valid | Not Valid |
|---|---|
| Vca | Vab, Vbc,- Incorrectly shows Vln values |
| kW tot | Vll avg - Incorrect |
| kVAr tot | Ia, Ib, Ic - Incorrect |
| kVA tot | |
| pf tot | |

How do I connect / wire a contactor and overload to create a Direct On Line (DOL) Starter?

Attached is a .pdf file with pictorial diagrams [(1)] of how you would connect the four most common variants of a DOL starter.

They show diagrams for 240 and 415 VAC control. The most common for small Direct On-Line Starters (DOLs) is 415VAC, as this requires no neutral to be fed to the starter.

Options are also given for using either a remote stop switch or for using the stop button which is integral with the overload. In the latter case the stop button is not a switch, it is a plunger type device fitted into the l

Remote and Emergency stops[2] are shown fitted between terminals A2 and 96, though they can also be fitted between 14 and 95, or even both if multiple stops are involved.

**Warning**

Particular care must be taken to accurately fit the stop button when using the plunger type stop without any additional remote stop, as if for any reason the plunger does not activate the stop button on the overload, t

**NOTES:**

**(1) These drawings are functional schematics. It remains the responsibility of the installer to ensure that the requirements of local directives and legislation are met and that appropriate circuit protecti**

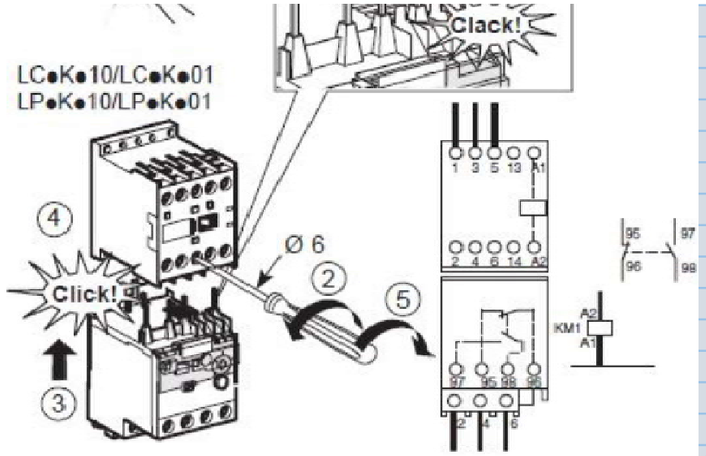
**(2) Inclusion of E stops in these circuits is purely for illustrative purposes and may be acceptable in simple relatively low risk safety systems. However, depending on the risk assessment carried out on t**

**NOTE regarding Terminal Numbering**

The circuits are based upon TeSys D range contactors and overloads. Terminal numbering is to a common standard so most other contactors can be wired similarly. However, be aware that there are contactors that

**NOTE if using TeSys K**

The TeSys LR2K overloads (LR2K****) for use with TeSys K range contactors (LC1K****) have additional pins on their overloads to make direct connection to terminals 14 on contactor to 95 on overload and A




**However, doing this is just making extra work. It is better to wire in accordance with the K Series diagram.**

Released for:Schneider Electric UK

**Attachment(s)**

K series DOL Wiring 3ph.pdf [260.91 KB]

Typical DOL start circuits.pdf [566.91 KB]

Published on:12/12/2011Last Modified on:07/11/2024

Did this answer your question?

98% of pe

TeSys™ T LTMR Motor Management Controller – Installation Guide

English

· Hazard Categories and Special Symbols
o Please Note
· About the Book
· Introducing the TeSys T Motor Management System
· Installation
· Commissioning
· Maintenance
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· Glossary
1. TeSys™ T LTMR Motor Management Controller – Installation Guide
2. Hazard Categories and Special Symbols

DOCA0128EN-02

## Hazard Categories and Special Symbols

Read these instructions carefully and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this bu

The addition of either symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

**NOTE:** Provides additional information to clarify or simplify a procedure.

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Was this helpful?

## Document Scope

This guide describes the TeSys™ T LTMR motor management controller and LTME expansion module.

The purpose of this guide is to:

- Describe and explain the monitoring, protection, and control functions of the LTMR controller and LTME expansion module
- Provide all the information necessary to implement and support a solution that best meets your application requirements

The guide describes the four key parts of a successful system implementation:

- Installing the LTMR controller and LTME expansion module
- Commissioning the LTMR controller by setting essential parameter values
- Using the LTMR controller and LTME expansion module, both with and without additional human-machine interface devices
- Maintaining the LTMR controller and LTME expansion module

This guide is intended for:

- Design engineers
- System integrators
- System operators
- Maintenance engineers

## Validity Note

This guide is valid for all LTMR controllers. Some functions are available depending on the communication protocol and the software version of the controller.

## Related Documents

Expand Table

| Title of Documentation | Description | Reference Number |
|---|---|---|
| TeSys T LTMR - Motor Management Controller - User Guide | This is the main user guide that introduces the complete TeSys T range and describes the main functions of the TeSys T LTMR motor management controller and LTME expansion module. | DOCA0127EN |

| | | | |
|---|---|---|---|
| TeSys T LTMR - Motor Management Controller - Ethernet Communication Guide | This guide describes the Ethernet network protocol version of the TeSys T LTMR motor management controller. | DOCA0129EN | |
| TeSys T LTMR - Motor Management Controller - Modbus Communication Guide | This guide describes the Modbus network protocol version of the TeSys T LTMR motor management controller. | DOCA0130EN | |

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| TeSys T LTMR - Motor Management Controller - PROFIBUS DP Communication Guide | This guide describes the PROFIBUS DP network protocol version of the TeSys T LTMR motor management controller. | DOCA0131EN | |
| TeSys T LTMR - Motor Management Controller - CANopen Communication Guide | This guide describes the CANopen network protocol version of the TeSys T LTMR motor management controller. | DOCA0132EN | |

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| TeSys T LTMR - Motor Management Controller - DeviceNet Communication Guide | This guide describes the DeviceNet network protocol version of the TeSys T LTMR motor management controller. | DOCA0133EN | |
| TeSys® T LTM CU - Control Operator Unit - User Manual | This manual describes how to install, configure, and use the TeSys T LTMCU Control Operator Unit. | 1639581EN | |
| Compact Display Units - Magelis XBT N/XBT R - User Manual | This manual describes the characteristics and presentation of the XBT N/XBT R display units. | 1681029EN | |

| | | | |
|---|---|---|---|
| TeSys T LTMR Ethernet/IP with a Third-Party PLC - Quick Start Guide | This guide provides a single reference for configuring and connecting the TeSys T and the Allen-Bradley programmable logic controller (PLC). | DOCA0119EN | |
| TeSys T LTM R Modbus - Motor Management Controller - Quick Start Guide | This guide uses an application example to describe the different steps to quickly install, configure, and use TeSys T for Modbus network. | 1639572EN | |

| | | | |
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| TeSys T LTM R Profibus-DP - Motor Management Controller - Quick Start Guide | This guide uses an application example to describe the different steps to quickly install, configure, and use TeSys T for PROFIBUS-DP network. | 1639573EN | |
| TeSys T LTM R CANopen - Motor Management Controller - Quick Start Guide | This guide uses an application example to describe the different steps to quickly install, configure, and use TeSys T for CANopen network. | 1639574EN | |

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|---|---|---|---|
| TeSys T LTM R DeviceNet - Motor Management Controller - Quick Start Guide | This guide uses an application example to describe the different steps to quickly install, configure, and use TeSys T for DeviceNet network. | 1639575EN | |
| Electromagnetic Compatibility - Practical Installation Guidelines | This guide provides an insight to the electromagnetic compatibility. | DEG999EN | |

| | | | |
|---|---|---|---|
| TeSys T LTM R•• - Instruction Sheet | This document describes the mounting and connection of the TeSys T LTMR motor management controller. | AAV7709901 | |
| TeSys T LTM E•• - Instruction Sheet | This document describes the mounting and connection of the TeSys T LTME expansion module. | AAV7950501 | |
| Magelis Compact Terminals XBT N/R/RT - Instruction Sheet | This document describes the mounting and connection of the Magelis XBT-N. | 1681014 | |

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|---|---|---|---|
| TeSys T LTM CU• - Instruction Sheet | This document describes the mounting and connection of the TeSys T LTMCU control unit | AAV6665701 | |
| TeSys T DTM for FDT Container - Online Help | This online help describes the TeSys T DTM and the custom logic editor embedded in the TeSys T DTM which allows the customization of the control functions of the TeSys T motor management system. | 1672614EN | |

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|---|---|---|
| TCSMCNAM3M002P USB to RS485 Converter - Quick Reference Guide | This instruction guide describes the configuration cable between computer and TeSys T: USB to RS485 | BBV28000 |
| Electrical Installation Guide (Wiki version) | The aim of the Electrical Installation Guide (and now Wiki) is to help electrical designers and contractors to design electrical installations according to standards such as the IEC60364 or other relevant standards. | www.electrical-installation.org |

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· Wiring Diagrams
· Glossary
1. TeSys™ T LTMR Motor Management Controller – Installation Guide

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# Installation

## Overview

This chapter describes the physical installation and assembly of the LTMR controller and the LTME expansion module. It also explains how to connect and wire the controller terminal block, including communica

**DANGER**

HAZARD OF ELECTRIC SHOCK,
EXPLOSION, OR ARC FLASH

- Turn off all power supplying this equipment before working on it.

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices.

Failure to follow these instructions will result in death or serious injury.

**WARNING**

UNINTENDED EQUIPMENT OPERATION

- The application of this product requires expertise in the design and programming of control systems. Only persons with such expertise should be allowed to program and apply this product.

- Follow all local and national safety codes and standards.

- Follow all electromagnetic compatibility rules described in this guide.

- Follow all installation and wiring rules described in this guide.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

WARNING: This product can expose you to chemicals including lead and lead compounds, which are known to the State of California to cause cancer and birth defects or other reproductive harm. For more information go to www.P65Warnings.ca.gov.

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## Functional Safety Introduction

The TeSys T motor management system is a part of a global architecture. To provide the functional safety, some risks must be analyzed such as:

- Global functional risks
- Risk of hardware and software breakdown
- Electromagnetic environmental risks.

To reduce the electromagnetic environment risks, installation rules and wiring must be respected.

For more information on EMC, refer to the *Electrical Installation Guide* chapter *ElectroMagnetic Compatibility (Wiki version available in English only on www.electrical-installation.org)* .

## Installation Rules Mounting

### Overview

This section describes how to mount the LTMR controller and the LTME expansion module on a DIN rail, a solid mounting plate, or a pre-slotted mounting plate (known as a TE plate), such as a Telequick™ plate.

Reminder: The LTMR controller and its LTME expansion module must be mounted side by side, with the LTME expansion module on the left side of the LTMR controller, connected by the LTMCC004 connecting jumper Assembly.

## Mounting on DIN Rails

You can mount the controller and the expansion module on a 35 mm (1.38 in.) DIN rail with a thickness of 1.35 mm (0.05 in.) and 0.75 mm (0.02 in.). When mounted, the controller mounting feet may not extend beyond the cont

| Step | Action |
|---|---|
| 1 | On the back of the controller are two DIN rail clips. Fit the top clip onto the DIN rail. |
| 2 | Push the controller in toward the DIN rail until the bottom clip catches. The controller clicks into place. |

## Removing from DIN Rails

To remove the controller from the DIN rail:

| Step | Action |
|---|---|
| 1 | Using a screwdriver, pull down the white locking mechanism to release the controller. |

| | | |
|---|---|---|
| | 2 Lift the controller away from the DIN rail. | |
| | | |
| | | |

## Mounting on a Solid Mounting Plate

DOCA0128EN-02

# Wiring - Generalities

## Overview

The wiring of each part of the LTMR controller and the LTME expansion module is detailed further with its specificities:

- · Wiring the current transformers.
- · Wiring the ground current sensors.
- · Wiring the temperature sensors.
- · Wiring the power supply.
- · Wiring the logic inputs.
- · Wiring the logic outputs.
- Wiring the voltage transformers on the LTME expansion module.

The wiring of the communication port depends on the communication protocol and is described in each communication guides.

## Wiring Rules

The following wiring rules must be respected in order to reduce disturbance due to EMC on the behavior of the LTMR controller:

- Keep a distance as large as possible between the communication cable and the power and/or control cables (minimum 30 cm or 11.8 in.).
- Cross over different types of cables at right angles, if necessary.
- Do not bend or damage the cables. The minimum bending radius is 10 times the cable diameter.
- Avoid sharp angles of paths or passage of the cable.
- Use shielded cables to connect ground current sensors:
  - The cable shield must be connected to a protective ground at both ends.
  - The connection of the cable shield to the protective ground must be as short as possible.
  - Connect together all the shields, if necessary.
  - Perform the grounding of the shield with a collar.
- Add filters on contactor coils for all contactors and relays.
- Place the cable along the grounded plate around the withdrawable drawer.

For more information, refer to the *Electrical Installation Guide* (available in English only), chapter *ElectroMagnetic Compatibility (EMC)* .

## Wiring Diagram Example: LTMR Controls a Three-phase Motor

The following diagram shows the wiring of the LTMR controller and its LTME expansion module used to control a three-phase motor in three-wire (impulse) independent mode:

**A1, A2** LTMR controller power supply

**B1, B2** Power supply dedicated to logic outputs

## Wiring Diagram Example: LTMR Controls a Single-phase Motor

The following diagram shows the wiring of the LTMR controller and its LTME expansion module used to control a single-phase motor in three-wire (impulse) independent mode:

**A1, A2** LTMR controller power supply

**B1, B2** Power supply dedicated to logic outputs

## LTMR Controller Plug-in Terminals and Pin Assignments

The LTMR controller has the following plug-in terminals and pin assignments:

| Terminal Block | Pin | Description |
|---|---|---|
| Control voltage, logic input, and common source terminals | A1 | Supply voltage input (+ / ~) |
| | A2 | The negative of a power supply for DC models, or the grounded secondary of a control power transformer for AC models (– / ~) |
| | I.1 | Logic input 1 |
| | I.2 | Logic input 2 |
| | I.3 | Logic input 3 |

| | | | |
|---|---|---|---|
| | I.4 | Logic input 4 | |
| | I.5 | Logic input 5 | |
| | I.6 | Logic input 6 | |
| | C | Input common | |
| O.4 Logic output terminals | 97–98 | NO contact | |
| | 95–96 | NC contact | |

| | | | |
|---|---|---|---|
| | **Note:** The 97–98 contacts and the 95–96 contacts are on the same relay, so the open/closed status of one pair of contacts is always the opposite of the status of the other pair. | | |
| O.1 to O.3 Logic output terminals | 13–14 | NO contact – logic output 1 | |
| | 23–24 | NO contact – logic output 2 | |
| | 33–34 | NO contact – logic output 3 | |

The LTMR controller has the following plug-in terminals and pin assignments for different communication protocols:

Expand Table

| **Communication Protocol** | **Terminal Block** | **Pin** | **Description** |
|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| Ethernet | Ground current trip input and temperature sensor input | Z1–Z2 | Connection for external ground current sensor | |
| | | T1–T2 | Connection for motor temperature sensors | |
| PROFIBUS DP | Ground current trip input and temperature sensor input, and PLC terminals | Z1–Z2 | Connection for external ground current sensor | |
| | | T1–T2 | Connection for embedded motor temperature sensing elements | |
| | | S | PROFIBUS DP shield or FE pin | |
| | | A | Receive/transmit data-N pin; A-line | |

| | | | | |
|---|---|---|---|---|
| | | B | Receive/transmit data-P pin; B-line | |
| | | DGND | Data ground pin | |
| | | VP | Power supply pin) | |
| CANopen | Ground current trip input, and temperature sensor input, and PLC terminals | Z1–Z2 | Connection for external ground current sensor | |
| | | T1–T2 | Connection for embedded motor temperature sensing elements | |
| | | V- | CANopen common pin | |
| | | CAN.L | CAN.L pin (dominant low) | |
| | | S | CANopen shield pin | |

| | | | | |
|---|---|---|---|---|
| | | CAN.H | CAN.H pin (dominant high) | |
| | | V+ | CANopen external power supply) | |
| DeviceNet | Ground current trip input and temperature sensor input, and PLC terminals | Z1–Z2 | Connection for external ground current sensor | |
| | | T1–T2 | Connection for embedded motor temperature sensing elements | |
| | | V– | DeviceNet common pin | |
| | | CAN.L | DeviceNet CAN.L pin (dominant low) | |
| | | S | DeviceNet shield pin | |

| | | | |
|---|---|---|---|
| | | CAN.H | DeviceNet CAN.H pin (dominant high) |
| | | V+ | DeviceNet external power supply pin |

## LTME Expansion Module Plug-in Terminals and Pin Assignments

The LTME expansion module has the following plug-in terminals and pin assignments:

| **Terminal block** | **Pin** | **Description** |
|---|---|---|
| Voltage inputs | LV1 | Phase 1 input voltage |
| | LV2 | Phase 2 input voltage |
| | LV3 | Phase 3 input voltage |
| Logic inputs and common terminals | I.7 | Logic input 7 |
| | C7 | Common for I.7 |
| | I.8 | Logic input I.8 |
| | C8 | Common for I.8 |
| | I.9 | Logic input I.9 |
| | C9 | Common for I.9 |
| | I.10 | Logic input I.10 |

| | | | |
|---|---|---|---|
| | C10 | Common for I.10 | |

## Terminal Wiring Characteristics

Both the LTMR controller and LTME expansion module terminals have the same characteristics.

Terminals have an insulation rating of 320 Vac.

The following table describes the characteristics of cables that may be used to wire the terminals:

| **Cable Type** | **No. of Conductors** | **Conductor Section** | |
|---|---|---|---|
| | | **mm²** | **AWG** |
| Flexible (stranded) cable | Single conductor | 0.2...2.5 | 24...14 |
| | Two conductors | 0.2...1.5 | 24...16 |
| Solid cable | Single conductor | 0.2...2.5 | 24...14 |
| | Two conductors | 0.2...1.0 | 24...18 |
| Flexible (stranded) cable with insulated cable ends | Single conductor | 0.25...2.5 | 24...14 |
| | Two conductors | 0.5...1.5 | 20...16 |
| Flexible (stranded) cable with non-insulated cable ends | Single conductor | 0.25...2.5 | 24...14 |

| | | | |
|---|---|---|---|
| | Two conductors | 0.2...1.0 | 24...18 |

The following table describes the characteristics of the terminals:

| | | |
|---|---|---|
| **Pitch** | 5.08 mm | 0.2 in. |
| **Tightening torque** | 0.5 to 0.6 N•m | 5 lb-in |
| **Flat screwdriver** | 3 mm | 0.10 in. |

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You can mount the controller and the expansion module on a metal mounting plate using ST2.9 steel tapping screws: four for the controller and two for the expansion module. The thickness of the mounting plate must not excee

| Step | Action |
|---|---|
| 1 | Locate the four mounting holes at each corner of the controller and the two mounting holes on the expansion module. |

| | | |
|---|---|---|
| 2 | Position the controller and expansion module on the mounting plate, making sure to leave enough space for the clearance zone Dimensions. | |
| 3 | Insert each of the six tapping screws. | |

| | | |
|---|---|---|
| | 4 Use a screwdriver to tighten each screw and secure the controller and the expansion module in place. Torque to 1 N•m (8.8 lb-in). | |
| | | |
| | | |

## Mounting on a TE Plate

You can mount the controller and the expansion module on a TE plate, such as Telequick, using six mounting clips (AF1 EA4). When mounted, the controller mounting feet may extend beyond the controller dimensions by 8 mm (

| Step | Action |
|---|---|

| | | |
|---|---|---|
| 1 | Attach the six mounting clips to Telequick, as shown in the diagram below. The rounded edge should face upwards for the top clips, and downwards for the bottom clips. | |

| | | |
|---|---|---|
| 2 | Position the controller and expansion module on the clips so that the holes in the clips and the holes in the controller and expansion module align. Insert the screws in the holes and turn them slightly. | |

| | | |
|---|---|---|
| 3 | When the controller and expansion module are properly positioned, tighten first the bottom screws, then the top screws using a screwdriver. Torque to 1 N•m (8.8 lb-in). | |

## Operating Position

You can mount the controller and the expansion module at an angle of up to 90 degrees perpendicular to the normal vertical mounting plane.

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Installation rules that must be respected to enable the LTMR to operate correctly include:

- Installation rules for the components:
  - Association of the LTMR controller with the LTME expansion module.
  - Installation in a switchboard such as Okken, Blokset, or another type.
- · LTMR controller wiring rules:
  - Wiring of the power supply
  - Wiring of the I/Os: logic input wiring and logic output wiring
- Communication network wiring rules.

## Installation Rules in a Switchboard

The installation of the LTMR controller in the withdrawable drawer of a switchboard presents constraints specific to the type of switchboard:

- For installation of the LTMR controller in a Schneider Electric Okken switchboard, refer to the *Okken Communications Cabling & Wiring Guide* (available on request).
- For installation of the LTMR controller in a Schneider Electric Blokset switchboard, refer to the *Blokset Communications Cabling & Wiring Guide* (available on request).
- For installation of the LTMR controller in other types of switchboard, follow the specific EMC instructions described in this guide and refer to the relative instructions specific to your type of switch

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## Dimensions

### Overview

This section presents the dimensions of the LTMR controller and the LTME expansion module, as well as the dimensions of the clearance zone around the controller and the expansion module. Dimensio

### LTMR Controller Dimensions

**NOTE:** The height of the controller may increase when using alternate wiring terminals.

### LTME Expansion Module Dimensions

### Clearance Zone Dimensions

- For EMC (Electromagnetic Compatibility), it is recommended to mount a contactor at a distance of more than 5 cm (1.97 in) from the LTMR controller and LTME expansion module.
- The maximum rated ambient temperature of the controller depends on the clearance zone dimensions. They are shown in the following table.


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## Wiring - Power Supply

### Overview

The LTMR controller supply voltage can be:

- 24 Vdc, or
- 100…240 Vac

The following table presents LTMR controller and LTME expansion module association rules:

| | **LTMR•••BD (VDC)** | **LTMR•••FM (VAC)** |
|---|---|---|
| **LTME••BD (VDC)** | X | X |
| **LTME••FM (VAC)** | – | X |

**X** Association allowed

**–** Association not allowed

### DC Power Supply

A dedicated 24 Vdc power supply is necessary to supply:

- One or several LTMR controllers including the logic inputs of the LTMR controller(s).
- The logic inputs of the LTME expansion module(s).

An additional specific 24 Vdc power supply is necessary to supply:

- The LTMR controller logic outputs.
- Other devices.

The LTMR controller DC power supply must have the following characteristics:

- AC/DC converter.
- Galvanic isolation input AC / output DC: 4 kVac minimum at 50 Hz.
- Input voltage: 240 Vac (+15% / -20%).
- Output voltage: 24 Vdc (+/-10%).

The following Schneider Electric ABL8RPS24••• power supplies are recommended:

| Reference Number | Input Voltage | Output Voltage/Current | Maximum Number of LTMR Controllers Supplied |
|---|---|---|---|
| ABL8RPS24100 | 200…500 Vac | 24 Vdc / 10 A | 24 |
| ABL8RPS24050 | 200…500 Vac | 24 Vdc / 5 A | 12 |
| ABL8RPS24030 | 200…500 Vac | 24 Vdc / 3 A | 8 |

## AC Power Supply

A dedicated AC/AC power supply or UPS is necessary to supply:

- One or several LTMR controllers including the logic inputs of the LTMR controller(s).
- The logic inputs of the LTME expansion module(s).

An additional specific AC or DC power supply is necessary to supply:

- The LTMR controller logic outputs.
- Other devices.

The LTMR controller AC power supply or UPS must have the following characteristics:

- Isolation transformer
- Output voltage: 115 or 230 Vac (+15% / -20%)
  - 115 Vac output voltage is recommended.
  - With 230 Vac output voltage, an additional LTM9F external filter may be necessary.
- Power according to the number of LTMR controllers (several AC supplies are recommended).
- UPS is mandatory if voltage is unstable and does not follow EN 50160.

## Power Supply Daisy Chaining

When the same power supply (AC or DC) is used to supply several LTMR controllers, it is recommended to close the loop:

- To avoid power off,
- To reduce voltage drop due to long cables.

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# Wiring - Logic Inputs

## Overview

10 logic inputs maximum are provided:

- Six logic inputs on the LTMR controller, internally powered by the LTMR.
- Four logic inputs on the LTME expansion module, independently powered.

## Logic Inputs of the LTMR Controller

The controller LTMR has six logic inputs:

- Available via field wiring terminals I.1- I.6.
- Internally powered by the control voltage of the LTMR controller (the input voltage is the same voltage as the controller supply voltage.)
- Isolated from the inputs of the LTME expansion module.

The three Common (C) terminals of the LTMR controller are connected to the A1 control voltage via an internal filter, as shown in the wiring diagram examples.

**NOTICE**

LOGIC INPUTS DESTRUCTION
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•Connect the LTMR controller’s inputs using the three Common (C) terminals connected to the A1 control voltage via an internal filter.

- Do not connect the Common (C) terminal to the A1 or A2 control voltage inputs.

Failure to follow these instructions can result in equipment damage.

For more information, refer to the power supply wiring and the technical specifications of the LTMR controller in the TeSys T LTMR Motor Management Controller User Guide.

## Logic Inputs of the LTME Expansion Module

The four logic inputs on the LTME expansion module (I.7 - I.10) are not powered by the control voltage of the LTMR controller.

For more information, refer to the technical specifications of the LTME expansion module in the TeSys T LTMR Motor Management Controller User Guide and to the power supply description.

## Controller AC Inputs Setting

The LTMR controller uses digital filters to obtain a correct AC signal on the inputs.

For more accurate results, this filter can be configured by the controller AC inputs setting register to set the voltage supply and activate the adaptive filtering internal feature.

## Connection of the Logic Inputs

**NOTICE**

| UNINTENDED EQUIPMENT OPERATION |
| --- |
| •Install interposing relay for long distance inputs. |

•Segregate control
cable from power cable.

•□Use dry contact on LTMR inputs.

| | |
|---|---|
| • Respect the recommendations given in this chapter. | |
| | |
| | |
| Failure to follow these instructions can result in unwanted motor stops. | |
| Three types of connection are possible:<br>• Direct connection for all information on logic inputs coming from the switchboard.<br>• Connection via interposing relays for all information on logic inputs coming from outside of the switchboard and mainly connected with long lines.<br>Using interposing relays reduces EMC disturbance effects on the LTMR controller and improves the reliability of the information.<br>• Connection without interposing relays for logic input on short distance. | |
| For TeSys T inputs / outputs applications, only dry contacts free of potential can be used. Otherwise, current could be supplied to sensor or device and affect the input / output state. | |
| Inductive Interference | |
| For parallel cable runs above 100 m (328 ft) with close proximity between control and power, an induced voltage can be generated and cause the relay to remain blocked. It is highly recommended to separate contr | |
| Maximum Distance Without Interposing Relay | |
| The maximum distance allowed without interposing relay is addressed below: | |

| | | | | |
|---|---|---|---|---|
| **Wire Size** | 1 $mm^2$ (AWG 18) | 1.5 $mm^2$ (AWG 16) | 2 $mm^2$ (AWG 14) | 2.5 $mm^2$ (AWG 14) |
| **Maximum distance for wires** | 210 m (689 ft) | 182 m (597 ft) | 163 m (535 ft) | 149 m (489 ft) |

However, due to variability of installations it is highly recommended to use interposing relays for control cable lengths longer than 100 m (328 ft).

## Recommended Interposing Relay

Interposing relays must have the following characteristics:

- Electromechanical relay with 2.5 kVac isolation minimum.
- Self-cleaning or low level contact (I < 5 mA).
- Installed in the switchboard as close as possible to the LTMR controller.
- AC or DC control circuit voltage, supplied by separate power supply (not supplied by the same power supply as the LTMR controller to respect the galvanic isolation).

In case of long distances between the process and the LTMR controller, interposing relays with DC control circuit voltage are recommended.

The protection module is mandatory on the interposing relays in order to suppress the surge.

The following Schneider Electric RSB1 interposing relays are recommended:

| Reference Number | Control Circuit Voltage | Protection Module |
|---|---|---|
| RSB1A120•D | 6, 12, 24, 48, 60, 110 Vdc | Diode RZM040W |
| RSB1A120•7 | 24, 48 Vac | RC circuit RZM041BN7 |
| RSB1A120•7 | 120, 220, 230, 240 Vac | RC circuit RZM041FU7 |

## Use of DC Interposing Relays

The DC interposing relays are recommended because long wires distances can be used to command the relay.

| | | | |
|---|---|---|---|
| **DC RSB1 relay voltage** | 24 Vdc | 48 Vdc | 110 Vdc |
| **Maximum distance for wires in parallel without metallic screening** | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) |

| | | | | |
|---|---|---|---|---|
| **Maximum distance for wires in parallel with metallic screening** | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | |

The following diagram shows an example when using DC interposing relays:

## Use of AC Interposing Relays

The use of an AC interposing relay is allowed only on short distances if an AC voltage is mandatory.

| | | | | |
|---|---|---|---|---|
| **AC RSB1 relay voltage** | 24 Vac | 48 Vac | 120 Vac | 230/240 Vac |
| **Maximum distance for wires in parallel without metallic screening** | 3,000 m (10,000 ft) | 1,650 m (5,500 ft) | 170 m (550 ft) | 50 m (165 ft) |
| **Maximum distance for wires in parallel with metallic screening** | 2,620 m (8,600 ft) | 930 m (3,000 ft) | 96 m (315 ft) | 30 m (100 ft) |

The following diagram shows an example when using AC interposing relays:

## Use of AC Interposing Relays with a Rectifier

The use of AC interposing relay with a rectifier is recommended on long distances if an AC voltage is mandatory.

Add a rectifier composed of 1 A / 1,000 V diodes to command an AC interposing relay. In this way, rectified AC current flows in the control cable when the switch in the continuous part is closed.

Relay drop out time increases with the stray capacitance (long cable length) because the capacitance reduces the inductive behavior of the coil. The equivalent component tends to be a resistor increasing the drop-o

| | | | | | |
|---|---|---|---|---|---|
| **AC RSB1 relay voltage** | 24 Vac | 48 Vac | 120 Vac | 230/240 Vac | |
| **Maximum distance for wires in parallel without metallic screening** | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | |
| **Maximum distance for wires in parallel with metallic screening** | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | 3,000 m (10,000 ft) | |

The following diagram shows an example when using AC interposing relays with a rectifier:

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# Wiring - Logic Outputs

## Overview

The four logic outputs of the LTMR controller are relay outputs. The relay outputs command the motor managed by the LTMR controller.

The four relay outputs on the LTMR controller are:

- Three single pole / single throw (SPST, NO) relay outputs
- One double pole / single throw (DPST, NC+NO) relay output

## Output Interposing Relays

When an output commands a contactor, an interposing relay may be required depending of the coil voltage and the power required by the contactor used.

The following diagrams illustrate system wiring without and with the use of an interposing relay KA1:

**B1, B2** Power supply dedicated to logic outputs

The LTMR controller logic output characteristics are:

- Rated insulation voltage: 300 V
- AC rated thermal load: 250 Vac / 5 A
- DC rated thermal load: 30 Vdc / 5 A
- AC 15 rating: 480 VA, 500,000 operations, Ie max = 2 A
- DC 13 rating: 30 W, 500,000 operations, Ie max = 1.25 A

If the LTMR controller logic output is not able to control directly the contactor, an interposing relay is required.

The protection module is mandatory on the interposing relays in order to suppress the surge.

### Recommended Contactors

The tables in the appendix, listing the references and characteristics of Schneider Electric contactors, specify whether an interposing relay is required or not. Refer to the Recommended Contactors in the *TeSys T LT*

# Connecting to an HMI Device

### Overview

This section describes how to connect the LTMR controller to an HMI device, such as a Magelis XBT or a TeSys T LTMCU, or to a PC running SoMove with the TeSys T DTM. The HMI device must be connecte

The Magelis XBT HMI device must be powered separately. Connect it to a controller in one-to-many mode.

### Wiring Rules

The wiring rules must be respected in order to reduce disturbance on the behavior of the LTMR controller due to EMC.

The exhaustive list of wiring rules is described in the general recommendations.

**NOTICE**

UNINTENDED EQUIPMENT OPERATION

Use Schneider Electric standard cables.

Failure to follow these instructions can result in equipment damage.

### Connecting to a Magelis XBT HMI Device in One-to-Many Mode

The diagram below shows a one-to-many connection from the Magelis XBTN410 HMI to up to eight controllers, with and without the LTME expansion module:

**1** Magelis XBTN410 HMI device
**2** Magelis connecting cable XBTZ938
**3** T-junction boxes VW3 A8 306 TF••
**4** Shielded cable with two RJ45 connectors VW3 A8 306 R••
**5** Line terminator VW3 A8 306 R
**6** LTMR controller
**7** LTME expansion module

## Connecting to a TeSys T LTMCU HMI Device

The diagrams below show the TeSys T LTMCU HMI device connected to the LTMR controller, without and with the LTME expansion module:

**1** LTMCU Control Operator Unit
**2** Grounding collar
**3** LTM9CU•• HMI device connection cable
**4** LTMR controller
**5** LTME expansion module

## Connecting to a Generic HMI Device

Connect the LTMR controller and the expansion module to an HMI device of your choice, using a shielded cable for Modbus bus, reference TSX CSA •••.

The RJ45 port pinouts to connect to the HMI port of the LTMR controller or the LTME expansion module is:

The RJ45 wiring layout is:

| Pin No. | Signal | Description |
|---|---|---|
| 1 | Reserved | Do not connect |
| 2 | Reserved | Do not connect |
| 3 | – | Not connected |
| 4 | D1 or D(B) | Communication between HMI and LTMR controller |

| | | | |
|---|---|---|---|
| 5 | D0 or D(A) | Communication between HMI and LTMR controller | |
| 6 | Reserved | Do not connect | |
| 7 | VP | +7 Vdc (100 mA) power supply provided by the LTMR controller | |
| 8 | Common | Signal and power supply common | |

**Connecting to a PC Running SoMove with the TeSys T DTM in One-to-One Mode Using the HMI Port**

The diagrams below show a one-to-one connection from a PC running SoMove with the TeSys T DTM to the HMI port of the LTMR controller, with and without the LTME expansion module and the LTMCU:

**1** PC running SoMove with the TeSys T DTM
**2** TCSMCNAM3M0 Modbus USB/RJ45 cable
**3** LTMR controller
**4** LTME expansion module

**1** PC running SoMove with the TeSys T DTM
**2** Cable kit TCSMCNAM3M002P
**3** LTMR controller
**4** LTME expansion module
**5** LTMCU Control Operator Unit
**6** Grounding collar
**7** LTM9CU•• HMI device connection cable

**Connecting to a PC Running SoMove with the TeSys T DTM in One-to-One Mode Using One LTMR Ethernet Network Port**

The diagrams below show a one-to-one connection from a PC running SoMove with the TeSys T DTM to one of the two network ports of the LTMR Ethernet controller, with and without the LTME expansion mo

**1** PC running SoMove with the TeSys T DTM
**2** Cat 5 shielded or unshielded twisted pair Ethernet cable
**3** LTMR Ethernet controller
**4** LTME expansion module

**1** PC running SoMove with the TeSys T DTM
**2** Cat 5 shielded or unshielded twisted pair Ethernet cable
**3** LTMR Ethernet controller
**4** LTME expansion module
**5** LTMCU Control Operator Unit
**6** Grounding collar
**7** LTM9CU•• HMI device connection cable

When the LTMCU is connected to a PC, the LTMCU becomes passive and cannot be used to visualize information.

## Connecting to a PC Running SoMove with the TeSys T DTM in One-to-Many Mode

The diagram below shows a one-to-many connection from a PC running SoMove with the TeSys T DTM to up to eight controllers (with or without the LTME expansion module):

**1** PC running SoMove with the TeSys T DTM
**2** Cable kit TCSMCNAM3M002P
**3** T-junction boxes VW3 A8 306 TF••, including a shielded cable with two RJ45 connectors
**4** Shielded cable with 2 RJ45 connectors VW3 A8 306 R••
**5** Line terminator VW3 A8 306 R
**6** LTMR controller
**7** LTME expansion module

**NOTE:** For Modbus communication protocol, this connection requires to define different HMI communication addresses. The factory setting of the HMI port address is 1.

## Connection Accessories

The following table lists connection accessories for the Magelis XBT and other HMI devices:

| Designation | Description | Reference |
|---|---|---|

| | | | |
|---|---|---|---|
| T-junction boxes | Box with two RJ45 socket connectors for trunk cable and an integrated 0.3 m (1 ft) cable with one RJ45 plug connector for tap-off | VW3 A8 306 TF03 | |
| | Box with two RJ45 socket connectors for trunk cable and an integrated 1 m (3.2 ft) cable with one RJ45 plug connector for tap-off | VW3 A8 306 TF10 | |

| | | | |
|---|---|---|---|
| Line terminator for RJ45 connector | R = 120 Ω | VW3 A8 306 R | |
| Magelis connecting cable | Length = 2.5 m (8.2 ft) | XBTZ938 | |
| (Magelis XBTN410 only) | 25 pts SUB-D connector to connect to Magelis® XBT | | |
| Cable kit | Length = 2.5 m (8.2 ft) | TCSMCNAM3M002P | |
| | USB to RS 485 converter | | |
| Communication cables | Length = 0.3 m (1 ft) | VW3 A8 306 R03 | |
| | Length = 1 m (3.2 ft) | VW3 A8 306 R10 | |
| | Length = 3 m (3.2 ft) | VW3 A8 306 R30 | |
| HMI device connection cable | Length = 1 m (3.2 ft) | LTM9CU10 | |
| | Length = 3 m (9.6 ft) | LTM9CU30 | |

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# Configurable Parameters

## Overview

The configurable parameters for the LTMR controller and the LTME expansion module are described below. The sequence of parameter configuration depends on the configuration tool utilized, either an HMI devi
Parameters are grouped according to the TeSys T DTM parameter list tab. To help you find the link with the variable tables in the Use chapter, each parameter has its corresponding register number attached.

**WARNING**

RISK OF UNINTENDED CONFIGURATION AND OPERATION

When modifying parameter settings of the LTMR controller:

•□Be especially careful if you change parameter settings when the motor is running.

•Disable network control of the LTMR controller to prevent unintended parameter configuration and operation.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

**Phases**

| Parameter | Setting Range | Factory Setting |
|---|---|---|

| | | | |
|---|---|---|---|
| Motor phases | •□Three-phase motor | Three-phase motor | |
| | •□Single-phase motor | | |

**Operating Mode**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Motor operating mode | •□Overload 2-wire | Independent 3-wire | |
| | •□Overload 3-wire | | |

| | | | |
|---|---|---|---|
| | • Independent 2-wire | | |
| | • Independent 3-wire | | |

| | | | |
|---|---|---|---|
| | • Reverser 2-wire | | |
| | • Reverser 3-wire | | |

| | | | |
|---|---|---|---|
| | • Two-step 2-wire | | |
| | • Two-step 3-wire | | |

| | | | |
|---|---|---|---|
| | • Two-speed 2-wire | | |
| | • Two-speed 3-wire | | |
| | • Custom | | |
| Motor star-delta | 0 = disabled | 0 | |

| | | | |
|---|---|---|---|
| | 1 = enabled | | |

**Contactor**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Contactor rating | 1...1,000 A in increments of 0.1 A | 810 A | |

**Motor**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Motor nominal voltage | 110…690 V | 400 V | |
| Motor nominal power | 0.134...1339.866 HP | 10.05 HP | |
| Motor nominal power | 0.1...999.9 kW in increments of 0.1 kW | 7.5 kW | |
| Motor auxiliary fan cooled | • Disable | Disable | |
| | • Enable | | |

| | | | |
|---|---|---|---|
| Motor full load current ratio (FLC1) | 5...100 % FLCmax in increments of 1 % | 5 % FLCmax | |
| Motor full load current | – | – | |
| Motor high speed full load current ratio (FLC2) | 5...100 % FLCmax in increments of 1 % | 5 % FLCmax | |
| Motor high speed full load current (FLC2) | 0...100 A in increments of 1 A | 5:00 AM | |

**Load Current Transformer**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Load CT primary | 1...65,535 in increments of 1 | 1 | |
| Load CT secondary | 1...500 in increments of 1 | 1 | |
| Load CT multiple passes | 1...100 passes in increments of 1 | 1 | |

**Ground Current Sensor**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Ground current mode | •□Internal | Internal | |
| | •□External | | |
| Ground CT primary | 1...65,535 in increments of 1 | 1 | |
| Ground CT secondary | 1...65,535 in incr | | |

# Control

**Operating Mode**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Control direct transition | On / Off | Off | |
| Motor transition timeout | 0...999.9 s | 1 s | |

| | | | |
|---|---|---|---|
| Motor Step 1 to 2 threshold | 20...800 % FLC in increments of 1 % | 150 % FLC | |
| Motor Step 1 to 2 timeout | 0.1...999.9 s | 5 s | |

**Inputs/Outputs**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Controller AC logic inputs configuration | • Unknown | Unknown | |
| | • Lower than 170V 50Hz | | |

| | | | |
|---|---|---|---|
| | • Lower than 170V 60Hz | | |
| | • Greater than 170V 50Hz | | |

| | | | |
|---|---|---|---|
| | • Greater than 170V 60Hz | | |
| Logic input 3 external ready enable | • Disable | Disable | |
| | • Enable | | |

**Rapid Cycle**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Rapid cycle lockout timeout | 0...9999 s in increments of 1 s | 0 s | |

**Local/Remote Control**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Control remote channel setting | •□Network | Network | |
| | •□Terminal strip | | |
| | •□HMI | | |

| | | | |
|---|---|---|---|
| Control local channel setting | •□Terminal strip | Terminal strip | |
| | •□HMI | | |
| Control transfer mode | •□Bump | Bump | |
| | •□Bumpless | | |
| Control remote local buttons enable | •□Disable | Disable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Control remote local default mode | • Remote | Remote | |
| | • Local | | |
| Stop HMI disable | • Enable | Disable | |
| | • Disable | | |
| Stop terminal strip disable | • Enable | Disable | |

| | | | |
|---|---|---|---|
| | • Disable | | |

**Diagnostic**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Diagnostic trip enable | • Disable | Enable | |
| | • Enable | | |
| Diagnostic alarm enable | • Disable | Enable | |
| | • Enable | | |

| | | | |
|---|---|---|---|
| Wiring trip enable | •□Disable | Enable | |
| | •□Enable | | |
| Motor phases sequence | •□A B C | A B C | |
| | •□A C B | | |

**Trip and Alarm**

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Trip reset mode | •□Manual or HMI | Manual or HMI | |
| | •□Remote by network | | |
| | •□Automatic | | |

| | | | |
|---|---|---|---|
| Auto-reset attempts group 1 setting | 0 = manual, 1, 2, 3, 4, 5 = unlimited number of reset attempts | 5 | |
| Auto-reset group 1 timeout | 0...9,999 s in increments of 1 s | 480 s | |
| Auto-reset attempts group 2 setting | 0 = manual, 1, 2, 3, 4, 5 = unlimited number of reset attempts | 0 | |
| Auto-reset group 2 timeout | 0...9999 s in increments of 1 s | 1,200 s | |
| Auto-reset attempts group 3 setting | 0 = manual, 1, 2, 3, 4, 5 = unlimited number of reset attempts | 0 | |
| Auto-reset group 3 timeout | 0...9999 s in increments of 1 s | 60 s | |

## Communication

### Network Port Control and Fallback Configuration

For information about the configuration parameters of the communication network, refer to

- *TeSys T LTMR Ethernet Communication Guide*
- *TeSys T LTMR Modbus Communication Guide*
- *TeSys T LTMR PROFIBUS DP Communication Guide*

- *TeSys T LTMR CANopen Communication Guide*
- *TeSys T LTMR DeviceNet Communication Guide*

## HMI Port

Expand Table

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| HMI port address setting | 1...247 | 1 | |
| HMI port baud rate setting | • 4800 | 19,200 bits/s | |
| | • 9600 | | |
| | • 19,200 | | |
| | • Self detection | | |

| | | | |
|---|---|---|---|
| HMI port parity setting | • None | Even | |
| | • Even | | |
| HMI port endian setting | • LSW first (little endian) | MSW first (big endian) | |

| | | | |
|---|---|---|---|
| | • MSW first (big endian) | | |
| HMI port fallback setting | • Hold LO1 LO2 | LO1, LO2 off | |

| | | | |
|---|---|---|---|
| | • Run (2-step) or off | | |
| | • LO1, LO2 off | | |

| | | | |
|---|---|---|---|
| | •□LO1, LO2 on (ovl, ind, cust) or off | | |

| | | | |
|---|---|---|---|
| | • LO1 on or off (2-step) | | |
| | • LO2 on or off (2-step) | | |

| | | | |
|---|---|---|---|
| HMI port trip enable | •□Disable | Disable | |
| | •□Enable | | |
| HMI port alarm enable | •□Disable | Disable | |
| | •□Enable | | |
| Config via HMI engineering tool enable | •□Forbidden | Allowed | |

| | | | |
|---|---|---|---|
| | • Allowed | | |
| Config via HMI keypad enable | • Forbidden | Allowed | |
| | • Allowed | | |



## Thermal

### Thermal Overload

Expand Table

| Parameter | Setting Range | Factory Setting | |
|---|---|---|---|
| Thermal overload mode | • Definite | Inverse thermal | |

| | | | |
|---|---|---|---|
| | • Inverse thermal | | |
| Motor trip class | • Motor class 5 | Motor class 5 | |

| | | | |
|---|---|---|---|
| | • Motor class 10 | | |
| | • Motor class 15 | | |

| | | | |
|---|---|---|---|
| | • Motor class 20 | | |
| | • Motor class 25 | | |

| | | | |
|---|---|---|---|
| | • Motor class 30 | | |
| Thermal overload trip enable | • Disable | Enable | |
| | • Enable | | |
| Thermal overload trip reset threshold | 35...95 % in increments of 1 % | 75% | |

| | | | |
|---|---|---|---|
| Thermal overload alarm enable | • Disable | Enable | |
| | • Enable | | |
| Thermal overload alarm threshold | 10...100 % in increments of 1 % | 85% | |
| Long start trip timeout | 1...200 s in increments of 1 s | 10 s | |
| Thermal overload trip enable | • Disable | Enable | |
| | • Enable | | |

| | | | |
|---|---|---|---|
| Thermal overload trip definite timeout | 1...300 s in increments of 1 s | 10 s | |
| Thermal overload alarm enable | • Disable | Enable | |
| | • Enable | | |

## Motor Temperature

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|
| Motor temperature sensor type | • None | None | |
| | • PTC binary | | |

| | | | |
|---|---|---|---|
| | •□PT100 | | |
| | •□PTC analog | | |
| | •□NTC analog | | |
| Motor temperature sensor trip enable | •□Disable | Disable | |
| | •□Enable | | |

| | | | |
|---|---|---|---|
| Motor temperature sensor trip threshold | 20...6,500 Ω | 20 Ω | |
| Motor temperature sensor trip threshold degree | 0...200 °C | 0 °C | |
| Motor temperature sensor alarm enable | • Disable | Disable | |
| | • Enable | | |
| Motor temperature sensor alarm threshold | 20...6,500 Ω | 20 Ω | |
| Motor temperature sensor alarm threshold degree | 0...200 °C | 0 °C | |

urrent

## Ground Current

| Parameters | Setting range | Factory setting | |
|---|---|---|---|
| Ground current disable while motor starting | •□No | No | |
| | •□Yes | | |
| Ground current trip enable | •□Disable | Enable | |
| | •□Enable | | |
| Internal ground current trip threshold | 20...500 % FLCmin in increments of 1 % | 30 % FLCmin | |
| Internal ground current trip timeout | 0.5...25 s in increments of 0.1 s | 1 s | |

| | | | |
|---|---|---|---|
| External ground current trip threshold | 0.02...20 A in increments of 0.01 A | 1:00 AM | |
| External ground current trip timeout | 0.1...25 s in increments of 0.01 s | 0.5 s | |
| Ground Current alarm enable | • Disable | Enable | |
| | • Enable | | |
| Internal ground current alarm threshold | 50...500 % FLCmin in increments of 1 % | 50 % FLCmin | |
| External ground current alarm threshold | 0.02...20 A in increments of 0.01 A | 1:00 AM | |

## Phases

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Current phase imbalance trip enable | • Disable | Enable | |
| | • Enable | | |
| Current phase imbalance trip threshold | 10...70 % in increments of 1 % | 10% | |
| Current phase imbalance trip timeout starting | 0.2...20 s in increments of 0.1 s | 0.7 s | |
| Current phase imbalance trip timeout running | 0.2...20 s in increments of 0.1 s | 5 s | |
| Current phase imbalance alarm enable | • Disable | Disable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Current phase imbalance alarm threshold | 10...70 % in increments of 1 % | 10% | |
| Current phase loss trip enable | • Disable | Enable | |
| | • Enable | | |
| Current phase loss timeout | 0.1...30 s in increments of 0.1 s | 3 s | |
| Current phase loss alarm enable | • Disable | Enable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Current phase reversal trip enable | • Disable | Disable | |
| | • Enable | | |

Long Start

| Parameters | Setting range | Factory setting | |
|---|---|---|---|
| Long start trip enable | • Disable | Enable | |
| | • Enable | | |

| | | |
|---|---|---|
| Long start trip threshold | 100...800 % FLC in increments of 1 % | 100 % FLC |
| Long start trip timeout | 1...200 s in increments of 1 s | 10 s |

Jam

| **Parameters** | **Setting range** | **Factory setting** |
|---|---|---|
| Jam trip enable | •□Disable | Enable |
| | •□Enable | |
| Jam trip threshold | 100...800 % FLC in increments of 1 % | 200 % FLC |
| Jam trip timeout | 1...30 s in increments of 1 s | 5 s |

| | | | |
|---|---|---|---|
| Jam alarm enable | •□Disable | Disable | |
| | •□Enable | | |
| Jam alarm threshold | 100...800 % FLC in increments of 1 % | 200 % FLC | |

Undercurrent

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|
| Undercurrent Trip Enable | •□Disable | Disable | |
| | •□Enable | | |

| | | | |
|---|---|---|---|
| Undercurrent Trip Threshold | 30...100 % FLC in increments of 1 % | 50 % FLC | |
| Undercurrent Trip Timeout | 1...200 s in increments of 1 s | 10 s | |
| Undercurrent Alarm Enable | • Disable | Disable | |
| | • Enable | | |
| Undercurrent Alarm Threshold | 30...100 % FLC in increments of 1 % | 50 % FLC | |

## Overcurrent

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|
| Overcurrent trip enable | • Disable | Disable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Overcurrent Trip Threshold | 20...800 % FLC in increments of 1 % | 200 % FLC | |
| Overcurrent trip timeout | 1...250 s in increments of 1 s | 10 s | |
| Overcurrent alarm enable | • Disable | Disable | |
| | • Enable | | |
| Overcurrent alarm threshold | 20...800 % FLC in increments of 1 % | 200 % FLC | |

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# Voltage

## Phases

| Parameters | Setting range | Factory setting |
|---|---|---|
| Voltage phase imbalance trip enable | • Disable<br>• Enable | Disable |
| Voltage phase imbalance trip threshold | 3...15 % of the calculated imbalance in increments of 1 % | 10 % imbalance |
| Voltage phase imbalance trip timeout starting | 0.2...20 s in increments of 1 s | 0.7 s |

| | | | |
|---|---|---|---|
| Voltage phase imbalance trip timeout running | 0.2...20 s in increments of 1 s | 2 s | |
| Voltage phase imbalance alarm enable | • Disable | Disable | |
| | • Enable | | |
| Voltage phase imbalance alarm threshold | 3...15 % of the calculated imbalance in increments of 1 % | 10 % imbalance | |
| Voltage phase loss trip enable | • Disable | Disable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Voltage phase loss trip timeout | 0.1...30 s in increments of 0.1 s | 3 s | |
| Voltage phase loss alarm enable | • Disable | Disable | |
| | • Enable | | |
| Voltage phase reversal trip enable | • Disable | Disable | |
| | • Enable | | |

| Undervoltage | | | |
|---|---|---|---|
| **Parameters** | **Setting range** | **Factory setting** | |
| Undervoltage trip enable | •□Disable | Disable | |
| | •□Enable | | |
| Undervoltage trip threshold | 70...99 % of Motor nominal voltage in increments of 1 % | 85 % of Motor nominal voltage | |
| Undervoltage trip timeout | 0.2...25 s in increments of 0.1 s | 3 s | |
| Undervoltage alarm enable | •□Disable | Disable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Undervoltage alarm threshold | 70...99 % of Motor nominal voltage in increments of 1 % | 85 % of Motor nominal voltage | |

**Overvoltage**

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|
| Overvoltage trip enable | • Disable | Disable | |
| | • Enable | | |
| Overvoltage trip threshold | 101...115 % of Motor nominal voltage in increments of 1 % | 110 % of Motor nominal voltage | |

| | | | |
|---|---|---|---|
| Overvoltage trip timeout | 0.2...25 s in increments of 0.1 s | 3 s | |
| Overvoltage alarm enable | • Disable | Disable | |
| | • Enable | | |
| Overvoltage alarm threshold | 101...115 % of Motor nominal voltage in increments of 1 % | 110 % of Motor nominal voltage | |

**Voltage Dip**

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|
| Voltage dip mode | • None | None | |

| | | | |
|---|---|---|---|
| | • Load shedding | | |
| | • Auto-restart | | |
| Voltage dip threshold | 50...115 % of Motor nominal voltage in increments of 1 % | 65 % of Motor nominal voltage | |
| Load shedding timeout | 1...9999 s in increments of 1 s | 10 s | |

| | | | |
|---|---|---|---|
| Voltage dip restart threshold | 65...115 % of Motor nominal voltage in increments of 1 % | 90 % of Motor nominal voltage | |
| Voltage dip restart timeout | 0...9999 s in increments of 1 s | 2 s | |
| Voltage dip threshold | 50...115 % of Motor nominal voltage in increments of 1 % | 65 % of Motor nominal voltage | |
| Voltage dip restart threshold | 65...115 % of Motor nominal voltage in increments of 1 % | 90 % of Motor nominal voltage | |
| Voltage dip restart timeout | 0...9999 s in increments of 1 s | 2 s | |
| Auto restart immediate timeout | 0...0.4 s in increments of 0.1 s | 0.2 s | |
| Auto restart delayed timeout | 0...301 s in increments of 1 s | 4 s | |

## Power

## Underpower

| Parameters | Setting range | Factory setting | |
|---|---|---|---|
| Underpower trip enable | •□Disable | Disable | |
| | •□Enable | | |
| Underpower trip threshold | 20...800 % of Motor nominal power in increments of 1 % | 20 % of Motor nominal power | |
| Underpower trip timeout | 1...100 s in increments of 1 s | 60 s | |
| Underpower alarm enable | •□Disable | Disable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Underpower alarm threshold | 20...800 % of Motor nominal power in increments of 1 % | 30 % of Motor nominal power | |

### Overpower

| Parameters | Setting range | Factory setting | |
|---|---|---|---|
| Overpower trip enable | • Disable | Disable | |
| | • Enable | | |
| Overpower trip threshold | 20...800 % of Motor nominal power in increments of 1 % | 150 % of Motor nominal power | |

| | | | |
|---|---|---|---|
| Overpower trip timeout | 1...100 s in increments of 1 s | 60 s | |
| Overpower alarm enable | • Disable | Disable | |
| | • Enable | | |
| Overpower alarm threshold | 20...800 % of Motor nominal power in increments of 1 % | 150 % of Motor nominal power | |

## Under Power Factor

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|
| Under power factor trip enable | • Disable | Disable | |

| | | | |
|---|---|---|---|
| | • Enable | | |
| Under power factor trip threshold | 0...1 in increments of 0.01 | 0.6 | |
| Under power factor trip timeout | 1...25 s in increments of 0.1 s | 10 s | |
| Under power factor alarm enable | • Disable | Disable | |
| | • Enable | | |
| Under power factor alarm threshold | 0...1 in increments of 0.01 | 0.6 | |

## Over Power Factor

| **Parameters** | **Setting range** | **Factory setting** | |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Over power factor trip enable | •□Disable | Disable | |
| | •□Enable | | |
| Over power factor trip threshold | 0...1 in increments of 0.01 | 0.9 | |
| Under power factor trip timeout | 1...25 s in increments of 0.1 s | 10 s | |
| Over power factor alarm enable | •□Disable | Disable | |
| | •□Enable | | |

| | | |
|---|---|---|
| Over power factor alarm threshold | 0...1 in increments of 0.01 | 0.9 |

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## IEC Format Wiring Diagrams

### Overview

This section contains the wiring diagrams corresponding to the five pre-configured operating modes:

| | | |
|---|---|---|
| Overload | Monitoring of the motor load where control (start/stop) of the motor load is achieved by a mechanism other than the controller | |
| Independent | Direct-on-line (across-the-line) full-voltage non-reversing motor starting applications | |

| | | |
|---|---|---|
| Reverser | Direct-on-line (across-the-line) full-voltage reversing motor starting applications | |
| Two-Step | Reduced voltage starting motor applications, including: | |
| | • Wye-Delta | |

| | | |
|---|---|---|
| | •□Open Transition Primary Resistor | |

| | | |
|---|---|---|
| | • Open Transition Autotransformer | |
| Two-Speed | Two-speed motor applications for motor types, including: | |

| | | |
|---|---|---|
| | • Dahlander (consequent pole) | |
| | • Pole Changer | |

Each application is described individually, with:

| | | |
|---|---|---|
| One complete application diagram | 3-wire (impulse) terminal strip control | |
| (including power and control) | | |
| Three partial diagrams | 2-wire (maintained) terminal strip control | |
| (control logic input wiring variants) | 3-wire (impulse) terminal strip control with network control selectable | |
| | 2-wire (maintained) terminal strip control with network control selectable | |

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- ·· IEC Format Wiring Diagrams
- · NEMA Format Wiring Diagrams
  - o Overload Mode Wiring Diagrams
  - o Independent Mode Wiring Diagrams
  - o Reverser Mode Wiring Diagrams

o Two-Step Wye-Delta Mode Wiring Diagrams
o Two-Step Primary Resistor Mode Wiring Diagrams
o Two-Step Autotransformer Mode Wiring Diagrams
o Two-Speed Mode Wiring Diagrams: Single Winding (Consequent Pole)
o Two-Speed Mode Wiring Diagrams: Separate Winding

· Glossary Matrix-UPS frequently asked questions regarding installation, operation, and standards

**Article available in these languages:** Spanish

**Issue**

Where can I find the answers to commonly asked questions about the Matrix UPS?

**Product Line**

Matrix UPS

**Environment**

All serial ranges

**Cause**

Some common questions may arise during the installation or use of a Matrix UPS.

**Resolution**

This document provides the answers to commonly asked questions regarding installation of the APC Matrix UPS.

Installation Hints

1. Matrix-UPS should be set up on a solid level surface if possible. Padding on floor will help dampen system noise.
2. User needs to know input voltage to Matrix-UPS. If 240VAC input, Matrix-UPS Input Select Tap Wire must be moved.
3. Set Matrix-UPS EU (Electronics Unit, the top half of the unit) in place on top of Matrix-UPS IU (Isolation Unit, the bottom half of the unit) and tighten rear knob.
4. Add SmartCell battery packs to system, either on top of Matrix-UPS or by its side.
5. Hook Anderson connector from SmartCell battery pack to EU slot, then add SmartCell communications cable.

Note: Battery communication cable must go from EU's "batt com" input to the "output" marking of first SmartCell. Follow this pattern for additional SmartCell battery packs.

6. Once all pieces are connected, turn main circuit breaker located on the rear of Matrix-UPS IU to "ON" position.
7. Front LCD display should read On-line with a % load. If LCD display does not illuminate, press all three buttons found directly underneath the display simultaneously.
8. User can then scroll through menu option of the LCD display to check current Matrix-UPS settings.
9. Change the sensitivity setting to LOW (default is AUTO). This LOW setting is preferred.
10. Go to menu "UPS Tests" and perform a battery test.

Matrix-UPS Noises

The Matrix-UPS will make certain noises which are normal to its operation and are acceptable. If the noise is not typical there will probably be other circumstances or errors along with the sound. Below are some o

1. Loud Hum - This sound will be heard anytime the transformer is energizing (usually on startup) and is normal. The physical size of the transformer and the initial current surge into it causes this sound.
2. Beeping - The Matrix-UPS will make different beeps depending on the UPS condition or fault.
Line Failure - four beeps about every five seconds
Bypass - one beep every four seconds
Bypass with no battery communication - five beeps
Line failure with no battery communication - Continuous beeping
Failed self test - Chirping
3. Clicking/Fineline Output Regulation
This sound will be heard anytime the Matrix-UPS is adjusting taps for voltage regulation, the Matrix-UPS will maintain +/- 5 % on the output voltage. For the Matrix-UPS to switch taps, it will first go to battery ar

a ) The Matrix-UPS features a tap changing regulator at the input with 6 taps.
b ) Through proper selection of the input tap, the output voltage is maintained to within a narrow band; typically 5% of rated input voltage.
c ) Intelligent tap changer adapts to varying line conditions from the front LCD display "UPS Setup" menu.
d ) If any fault in the tap changer is detected the unit switches itself into bypass and displays "main relay fault" on the front LCD display.

Matrix-UPS Certifications, Listings and Safety Agency Approvals

**UL listed,** File # E95463: category YEDU - UPS Equipment, per UL 1778
**CSA certified,** File # LR63938: class 5311 05 - Power Supplies (Stand Alone), per standards C22.2 No 0, C22.2 No 0.4, C22.2 No 66, C22.2 No 107.1
**TUV certified:** per standards EN 60 950 and VDE 0558 (IEC 146-4)
**Novell Labs approved:** NetWare compatible
**FCC verified:** per FCC Rules Part 15, Class A Computing Devices
**EC verified:** per EN50082-1, EN50091-1, EN55022 Class A
**VCCI Class 1:** ITE
**Note:** The Matrix-UPS is not UL1449 approved

EMI / RFI

The Matrix-UPS and SmartCell system were tested to withstand radiated electromagnetic (EM) fields per the test methods of IEC standard 801.3. The UPS withstands EM fields of 10 V/m over a frequency range c

Matrix-UPS Thermal Dissipation

| Matrix-UPS 3000 | Matrix-UPS 5000 |
|---|---|
| On-Line 540 BTU/hr | On-Line 900 BTU/hr |
| On-Line/Charging 900BTU/hr | On-Line/Charging 1260 BTU/hr |

On-Battery 2000 BTU/hr On-Battery 3700 BTU/hr

Matrix-UPS Overload Rating

When the Matrix-UPS is on-line and overloaded, the input circuit breaker clearing times below can be expected.

| Overload | Min. Time | Max. Time |
|---|---|---|
| 200% | 10 sec. | 100 sec. |
| 500% | 1 sec. | 10 sec. |
| 1000% | 6 msec. | 2 sec. |
| 1200% | 5 msec. | 1 sec. |

If the overload continues for this amount of time the breaker will trip forcing the Matrix-UPS to battery. When the Matrix-UPS is on battery the inverter senses the overload and if it exceeds 100% of the UPS rated

Matrix-UPS Input Voltage

The Matrix-UPS 3000 and 5000 models are wired from the factory for 208 VAC input. This can be verified a couple of ways once the unit is installed.

1 ) Go to the front display of the Matrix-UPS and scroll through to the menu "UPS Status" to check the input line voltage, in some cases this value may be varying and not exactly at either 208 or 240 VAC.

2 ) From the diagnostics menu you can view the UPS FW REV, this screen will show the internal micro revision of the Matrix-UPS which will be followed by either a letter "I" or a letter "M". If the select tap is wi

3 ) If the user inputs 240 VAC but did not move the Input Voltage Select wire, the letter "M" will show under UPS FW REV. The Matrix-UPS will show a fault or stay on battery.

If the UPS Control menu selections are TURN UPS OFF and COLD START UPS, check the input voltage and circuit breaker. The UPS is not seeing any input voltage.

Matrix-UPS De rating

The Matrix-UPS 5 kVA is rated to work with a 30 Amp electrical service. Due to National Electrical Code (NEC) and Underwriters Laboratory (UL) restrictions, the maximum current drawn from such a service sh

With 240 VAC input, the unit is allowed to draw up to 5760 VA, so it can support a 5 kVA load even after allowing for small losses inside the unit. With 208 VAC input however, the unit can only draw a maximu

Matrix-UPS Transfer Time

1 ) Matrix-UPS transfer times to and from bypass:

The transfer times to the bypass mode of operation differs depending upon how the Matrix-UPS is commanded to go to bypass. The transfer time out of bypass is always the same regardless of how it is done.

- To Bypass - Commanded via the front panel display or software, 1 ms typical
  - Rear panel bypass switch, 4 ms typical
  - Loosening the Electronics unit separating screw - 4 ms typical, 10 ms max.
- From Bypass - Via front display or rear panel switch - 0 ms typical

Note that all types of UPSs exhibit a transfer time in going to bypass. Most on-line UPSs with bypass exhibit up to 8 ms of transfer time. It should be noted that this specification is usually unstated by the manufact

2 ) How does the Matrix-UPS achieve a zero transfer time:

The Matrix-UPS provides no-break, zero transfer backup power for protected computer loads. This performance is achieved by a combination of the following elements:

- Filter Isolates power failure from the load: The filtering elements in the Matrix-UPS, including the isolation transformer serve to isolate power faults from the protected load. Therefore, even if the input AC instantly falls to zero voltage, the output voltage is not affected for av
- High speed power fault detection: Power faults are detected by a high speed microprocessor in less than 200 microseconds. As soon as a fault is detected the power flow of the inverter is reversed so that it supplies th
- Input fault disconnection: A high speed switch made up of solid state devices and a rugged electrodynamics (relay) components quickly disconnects the input power when the inverter begins to supply battery power to

**Inverter is already on-line: The power inverter converts battery power to AC is already connected to the output at all times due to the line interactive topology. This inverter is already operating before the power fai**

The line interactive design of the Matrix-UPS does have power fault and corrections systems that take time to operate, but these brief delay times do not create a transfer time because the inverter is already on line a

Matrix-UPS vs. Ferro resonant UPS

The Ferro resonant UPS (or FerrUPS) is not only limited in its manageability but also very inflexible when changing platforms. Matrix-UPS supports multiple loads in parallel. When multiple loads are powered on

Compared to the isolation transformer, ferroresonant transformers are heavy, emit much heat, noisy, and large in size. Also, the ferro's tank circuit must see a constant flow of 60 Hz power, plus or minus a fraction

Matrix-UPS Efficiency

| Matrix-UPS 3000 | Matrix-UPS 5000 |
|---|---|
| 25% load > 84% | 25% load > 82% |
| 50% load > 90% | 50% load > 89% |
| 75% load > 91% | 75% load > 91% |
| 100% load > 92% | 100% load > 93% |

Matrix-UPS - "W" & "J" Options

Japanese Model

The Japanese Matrix-UPS requires an input voltage of either 200 VAC or 208 VAC. The output voltage can either be 100/200 VAC or 120/208/240 VAC as selected by the VSS (Voltage Selection Switch). This switch is located on top

Worldwide Model

The Matrix-UPS "W" (worldwide) has the ability to operate on a frequency of either 50 or 60HZ. **The unit is almost identical to the domestic Matrix and the differences are in the IU. All EU's are interchangeable** and can be used

Note: the MX5000J-EU can be used on a MX5000 worldwide or MX5000 domestic.

Options

The Matrix-UPS "W" (worldwide) has the ability to output 120 VAC by changing it's standard configuration. This is accomplished by either replacing the standard PDU with a domestic PDU plate ( X option-94 ) or by using the Matr

| APC Part Number | Description |
|---|---|
| MXA001 | MX5000 Hardwire Plate |
| MXA002 | MX3000 Hardwire Plate |
| MXA005 | Meridian Alarm Cable Kit |
| MXA006 | Matrix casters |
| MXA007 | Matrix Rack Shelf |
| MXA008 | SmartCell Extender Cables |
| MXA101 | PDU - 10 5-15R, 1 L14-30R |
| MXA102 | PDU - 4 L6-20R |
| MXA103 | PDU - 8 5 - 20R |
| MXA104 | PDU - 4 L6-30R |
| MXA105 | PDU - 4 L5 - 30R |
| MXA106 | PDU - 4 L5 - 20R |
| MXA107 | PDU - 4 L6-15R, 4 6-15R, 1 L6-30R |
| MXA108 | PDU - 6 L5-15R, 2 L14-30R |
| | |
| | |
| | |
| Harmonics | |
| Computers are non-linear loads that cause harmonics to flow in the power lines. Harmonics are currents that are multiples of the fundamental line frequency (50 or 60 HZ). The reason harmonics are a problem is due to two facto | |
| | |
| •□Harmonics overload the neutral wiring in buildings and create a potential fire hazard. | |
| | |

- Harmonics overload building power transformers and cause them to wear out.

Matrix-UPS helps reduce harmonics problems in the following ways:

- Matrix-UPS eliminates neutral currents: The Matrix-UPS does not use or need a neutral connection on its input. Matrix-UPS gets its input power from two single phase hot lines and a ground. The Matrix-UPS creates its
- Matrix-UPS reduces harmonics current in the hot wires: The Matrix-UPS reduces these currents in two ways. Matrix-UPS improves power factor and attenuates harmonic currents by about 20%. This reduces harmonic

Galvanic Isolation

Galvanic Isolation means that the output power circuit is electrically and physically isolated from the input power circuit. Electrical isolation is accomplished using an isolation transformer. Physical isolation means

Matrix-UPS and Batteries:

The Matrix-UPS has the ability to tell you many things about a user's site and often can provide the information needed to diagnose a problem right from it's own LCD display. Always ask questions that will charac

1 ) Line Voltage
2 ) Output Voltage
3 ) % Load
4 ) Battery Voltage
5 ) Last Reason for Transfer
6 ) Battery Capacity
7 ) Number of Batteries
8 ) Number of Bad Batteries
9 ) Internal Temperature
10 ) Bypass Enable/Disable
11 ) UPS FW Rev

The items in the above list may seem obvious but they play an important role in the diagnosis of the problem. From this data the next level of diagnosis can be performed such as checking to see if the transformer ta

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# Campus LAN and Wireless LAN Solution Design Guide

Updated:May 4, 2020

Campus quality of service (QoS)

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- o Campus quality of service (QoS)

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## Definition and Introduction: Campus LAN and Wireless LAN

There is a tendency to discount the network as simple plumbing — to believe that the only design considerations are the size and the length of the pipes or the speeds and feeds of the links, and to dismiss the rest as

Here are some key concepts that you should address when creating a reliable and versatile network design. The network should be:

- **Always on and resilient**—Continuously on and available.
- **Intelligent**—Adapting to changing needs, beyond the limits of basic standards, using insight into network activity.

- **Secure**—Protecting the organization and its users.

Planning for the Future

As you look at a network design, consider the networking trends and future needs of an organization.

- The network must be ready to appropriately scale over time in order to meet the demands of the organization it is supporting.
- Because demands on wireless access points (APs) with the latest standards, including Wi-Fi 6 (802.11ax) technology exceed 1 Gbps, and the IEEE has ratified the 802.3bz standard that defines 2.5 Gbps and 5 G
- As you deploy new devices with higher power requirements, such as lighting, surveillance cameras, virtual desktop terminals, remote access switches, and APs, your design should have the ability to support pow
- Compliance issues drive a choice of platforms required when you support standards certifications and MACsec. For those cases, you should also be prepared to make analytic data available, using technologies su
- The Internet of Things (IoT) impacts today's network design. Your network should support TrustSec and other segmentation and virtualization technologies, such as Cisco Software-Defined Access (SD-Access)
- Bandwidth needs are doubling potentially multiple times over the lifetime of a network so that the network deployed today needs to be prepared to aggregate using 10 Gbps Ethernet to 25 Gbps to 40 Gbps to 10
- The network platforms deployed today should offer the best longevity into the future, versus selecting the equipment that only meets the limits of today's needs.
- To reduce operational complexity, you can use a centralized controller with open APIs, allowing for very fast, lower-risk deployment of network devices and services through UI and existing orchestration systen

Cisco Digital Network Architecture (Cisco DNA)

Cisco Digital Network Architecture (Cisco DNA) provides a roadmap to digitization and a path to realize immediate benefits of network automation, assurance, and security. The campus local area network (LAN)

- The design of the campus wired LAN foundation.
- How the WLAN extends secure network access or is exclusive network access for your mobile workforce.
- How the WLAN can provide guest access for contractors and visitors to your facilities.

If you didn’t download this guide from Cisco Community or Design Zone, you can check for the latest version of this guide.

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- https://www.cisco.com/go/designzone
- https://cs.co/en-cvds

Design: Campus LAN and Wireless LAN

Designing a LAN for the campus use case is not a one-design-fits-all proposition. The scale of campus LAN can be as simple as a single switch and wireless AP at a small remote site or a large, distributed, multi-b

- Traditional Access- Dedicated Distribution and Access Layers (L2 or L3). You impose most of the campus wired LAN design complexity when aggregating groups of access switches by interconnecting the acc
- Simplified Access –Virtualized StackWise Access & StackWise Virtual Distribution. To improve the design, there are preferred alternatives that make the deployment easier to manage and less prone to mistake
- Cisco Software Defined Access – Campus Fabric and Automation of the Distribution & Access Layers. A design alternative is available for organizations that either don't have the need to extend Layer 2 connec

The motivation for the recommended design choices is not that they are the only options available but that the recommendations highlight preferred choices given the scope of the requirements. Even though the tra

When you integrate the wireless components of the campus design with the wired components, the design can often be treated as an overlay that is dependent upon the services provided by the underlying campus ir

The primary design options are grouped by scale, and then appropriate selections are based on the capabilities desired. The selection from the spectrum of capabilities is based on the needs of a specific deployment.

Design Fundamentals: Campus Wired LAN

The LAN is the networking infrastructure that provides access to network communication services and resources for end users and devices spread over a single floor or building. You create a campus network by int

The campus wired LAN enables communications between devices in a building or group of buildings, as well as interconnection to the WAN and Internet edge at the network core.

Specifically, this design provides a network foundation and services that enable:

- Tiered LAN connectivity.
- Wired network access for employees.
- IP Multicast for efficient data distribution.
- Wired infrastructure ready for multimedia services.

Hierarchical design model

The campus wired LAN uses a hierarchical design model to break the design up into modular groups or layers. Breaking the design up into layers allows each layer to implement specific functions, which simplifies

Modularity in network design allows you to create design elements that can be replicated throughout the network. Replication provides an easy way to scale the network as well as a consistent deployment method.

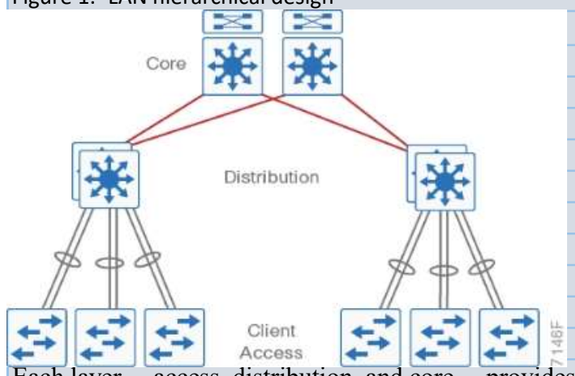
In flat or meshed network architectures, changes tend to affect a large number of systems. Hierarchical design helps constrain operational changes to a subset of the network, which makes it easy to manage as well a

Modular structuring of the network into small, easy-to-understand elements also facilitates resiliency via improved fault isolation.

A hierarchical LAN design includes the following three layers:

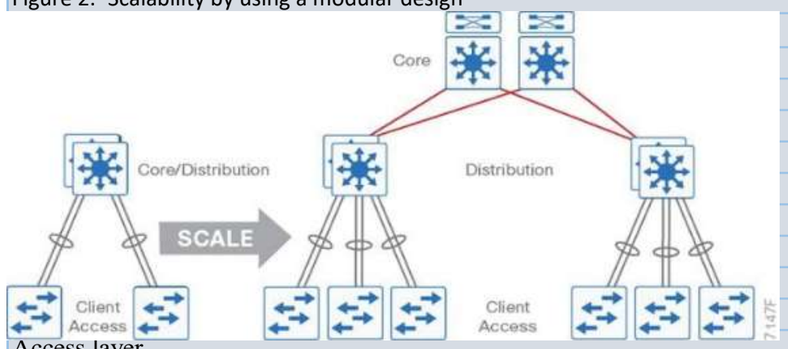
- **Access layer**—Provides endpoints and users direct access to the network
- **Distribution layer**—Aggregates access layers and provides connectivity to services
- **Core layer**—Provides connectivity between distribution layers for large LAN environments

Figure 1. LAN hierarchical design



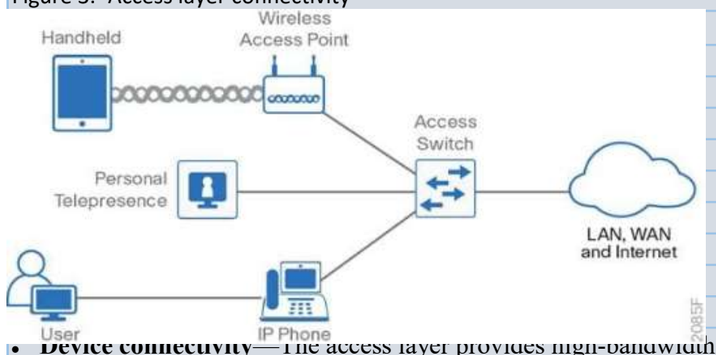

Each layer —access, distribution, and core— provides different functionality and capability to the network. Depending on the characteristics of the deployment site, you might need one, two, or all three of the layer
Regardless of how many layers are implemented at a location, the modularity of this design ensures that each layer will provide the same services, and in this architecture, will use the same design methods.

Figure 2. Scalability by using a modular design




Access layer
The access layer is where user-controlled devices, user-accessible devices, and other end-point devices are connected to the network. The access layer provides both wired and wireless connectivity and contains fea

Figure 3. Access layer connectivity




- **Device connectivity**—The access layer provides high-bandwidth device connectivity. To help make the network a transparent part of an end-user's day-to-day job, the access layer must support bursts of high-ba

Because many types of end-user devices connect at the access layer —personal computers, IP phones, wireless APs, and IP video surveillance cameras— the access layer can support many logical networks, deliver

- **Resiliency and security services**—The access-layer design must ensure that the network is available for all users who need it, whenever they need it. As the connection point between the network and client dev
- **Advanced technology capabilities**—The access layer provides a set of network services that support advanced technologies, such as voice and video. The access layer must provide specialized access for device

Multigigabit Ethernet (mGig) and PoE at the access-layer

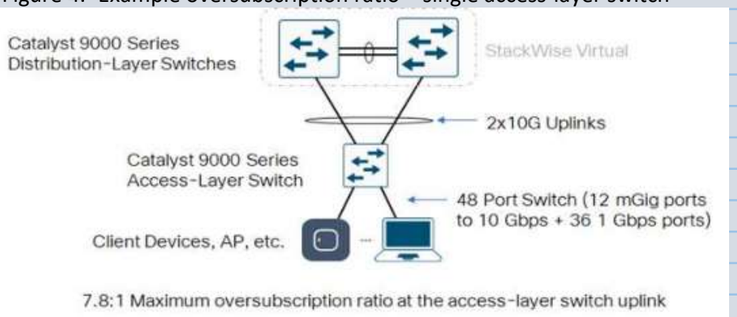
As customers migrate to 802.11ax (Wi-Fi 6), the access layer switch platforms to which the Catalyst 9100 Series APs connect may also need to be upgraded. Data rates above 1 Gbps, supported by 802.11ax (Wi-F

Oversubscription ratios

The migration to mGig may also require increasing uplink port speeds in order to maintain the desired oversubscription ratio. Determining the oversubscription ratio of the uplink when deploying mGig technology

For example, let's say you deploy a 48-port switch which supports mGig up to 10 Gbps on 12 access ports, 1 Gbps on the other 36 ports, and with 4x10 Gbps fixed uplinks. However, you only provision two 10 Gb

Figure 4. Example oversubscription ratio – single access-layer switch


Catalyst 9000 Series
Distribution-Layer Switches
StackWise Virtual
2x10G Uplinks
Catalyst 9000 Series
Access-Layer Switch
48 Port Switch (12 mGig ports
to 10 Gbps + 36 1 Gbps ports)
Client Devices, AP, etc.
7.8:1 Maximum oversubscription ratio at the access-layer switch uplink

The maximum potential bandwidth usage of the switch ports would be 12 x 10 Gbps = 120 Gbps plus 36 x 1Gbps = 36 Gbps, for a total 156 Gbps. The maximum uplink oversubscription ratio would be 156 Gbps

More realistically, you may have the following actually connected to the switch:

- 8 Catalyst 9100 Series APs operating at 5 Gbps connected to the switch ports
- 32 Cisco IP Phones and/or end-user devices (PCs, Mac's etc.) operating at 1 Gbps connected to the switch ports
- 8 Unused ports for future expansion and capacity

The actual potential bandwidth usage of the switch ports would be 8 x 5 Gbps = 40 Gbps plus 32 x 1 Gbps = 32 Gbps, for a total 72 Gbps. Therefore a more realistic view of the oversubscription ratio is 72 Gbps :

This configuration provides for additional capacity, in that you have an additional 2 x 10 Gbps unused uplinks as additional devices require mGig port speeds, as devices transition to 10 Gbps speeds, and as you ex

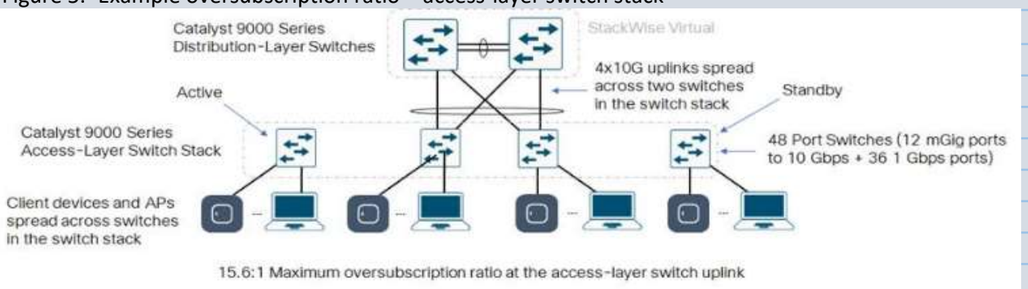
Switch stack configurations

Migrating to a switch stack is an effective, flexible, and scalable solution to expand network capacity at the access-layer. The benefits of a switch stack are as follows:

- The switch stack behaves as a single device (characteristics and functionality of a single switch)
- The switch stack allows expansion of switch ports without having to manage multiple devices
- Switches can be added or removed from the switch stack without affecting the overall operation of the switch stack
- Depending upon the configuration of the switch stack, it can continue to transmit data even if a link or switch within the stack fails

When adding additional access layer switches in a stackable configuration, you should design the switch stack with the desired oversubscription ratio both during normal operations, and if there is a failure of a swit

Figure 5. Example oversubscription ratio – access-layer switch stack




For example, let's say you deploy four 48-port switches each of which supports mGig up to 10 Gbps on 12 access ports, 1 Gbps on the other 36 ports, with fixed 4x10 Gbps uplink ports. However, you decide to us

The maximum potential bandwidth usage of the switch ports would be 48 x 10 Gbps = 480 Gbps plus 144 x 1 Gbps = 144 Gbps, for a total 624 Gbps. The maximum uplink oversubscription ratio would be 624 : 4

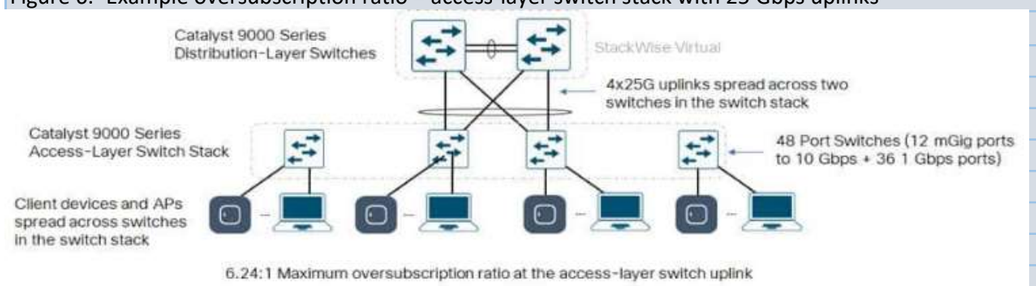
More realistically, you may have the following actually connected to the switch:

- 32 Catalyst 9100 Series APs operating at 5 Gbps connected across the switch stack
- 128 Cisco IP Phones and/or end-user devices (PCs, Mac's etc.) operating at 1 Gbps connected across the switch stack
- 32 unused ports across the switch stack for future capacity

The actual potential bandwidth usage of the switch ports would be 32 x 5 Gbps = 160 Gbps plus 128 x 1 Gbps = 128 Gbps, for a total 288 Gbps. Therefore a more realistic view of the oversubscription ratio is 288

Again, this configuration provides for additional capacity, in that you have an additional 12 x 10 Gbps unused uplinks across the switch stack, as additional devices require mGig port speeds, as devices transition to
If one of the switches with uplinks were to fail, the number of uplinks decreases to 2 x 10 Gbps. However, the number of ports also decreases by 48 switch ports. In this scenario, it is important to balance the devi
Another best practice is to select switches without uplinks as the active and standby of the switch stack, as shown in the figure above. Uplinks should be provisioned on the member switches. This way, if the activ
Modular access layer switch platforms
An alternative to deploying switch stacks at the access layer is to deploy modular switch platforms, such as the Catalyst 9400 Series. Catalyst 9400 Series 4, 7, or 10-slot models can be deployed, depending upon th
An advantage of modular platforms is that additional linecards can be added to empty slots within the chassis to increase capacity, without having to worry about whether additional rack space or power (assuming s
Another advantage of modular platforms is that they are typically designed such that the supervisor can be upgraded to increase the performance of the platform, without having to replace it. This can be a cost adva
As with switch stacks, uplinks should be spread across linecards within the modular chassis. Oversubscription ratios should be determined both during normal operations and during failure scenarios. APs and end
Increasing uplink speeds
As you continue to add more switches to a switch stack you must keep in mind the distribution of the uplinks across the switches in the switch stack, and the oversubscription ratio during failure scenarios. Likewis
Deploying multiple 10 Gbps uplinks may not be effective for larger switch stacks or modular platforms when migrating to mGig capable switches or linecards. The maximum number of links in an EtherChannel c
Hence, it may be more optimal to migrate to higher speed uplinks between the access layer switch or switch stack and the distribution layer switches.

Figure 6. Example oversubscription ratio – access-layer switch stack with 25 Gbps uplinks


Catalyst 9000 Series
Distribution-Layer Switches
StackWise Virtual
4x25G uplinks spread across two
switches in the switch stack
Catalyst 9000 Series
Access-Layer Switch Stack
48 Port Switches (12 mGig ports
to 10 Gbps + 36 1 Gbps ports)
Client devices and APs
spread across switches
in the switch stack
6.24:1 Maximum oversubscription ratio at the access-layer switch uplink

For example, instead of deploying four 48-port switches with fixed 4 x 10 Gbps uplinks in a switch stack configuration, you may want to deploy four 48-port switches along with a 2 x 25 Gbps uplink module in tw
This configuration provides up to 100 Gbps uplink bandwidth in a MEC configuration, when both switches with uplinks are operational. Fewer uplink ports are required at the distribution layer StackWise Virtual
- The optical transceiver modules which connect the distribution layer switches to the access layer switch platforms have to interoperate with each other and have to be compatible with the fiber optic building distr

**Note:** Cisco offers a gradual migration path with the support of dual-rate optics, where the same 25 Gbps optics can operate at both 10 Gbps and 25 Gbps speeds. With this approach, distribution layer devices car

- The distances supported by multimode fiber typically decrease as speeds increase. This means that if you are upgrading from 10 Gbps to 25 Gbps between the distribution layer and access layer switches, and yo

**Note:** The Cisco 10/25GBASE-CSR Module supports a link length of up to 300/400m over OM3/4 at 10G, and up to 300/400m over OM3/4 at 25G – depending upon the multimode fiber quality. It also supports

- If you have older multimode fiber (OM1), speeds above 10 Gbps may not be supported.

Single mode fiber generally supports both higher transmission rates and longer distances than multimode fiber.
Uplink queuing
The actual uplink oversubscription ratio that you implement between your access and distribution layer switches is dependent upon your business requirements. Uplink ratios up to 20:1 between the access and distr
Catalyst 9000 Series switches dynamically allocate buffer space across switch ports and queues in order to optimize the utilization of the existing buffer space. However, switch buffer space is a finite quantity that
It is recommended to implement queuing on switches, where oversubscription of ports can result in transient congestion, which can cause packet loss. Queuing ensures that when congestion occurs, your higher pri
Access layer variations
In some situations, such as for IoT and for multi-dwelling unit (MDU) deployments, the access layer is often augmented with additional cascaded switches. For Cisco Software-Defined Access (described later) acc
Access layer platforms
The preferred options for the campus wired LAN include the following Cisco switches as platforms for the access layer:

- Cisco Catalyst 9400 Series Switches (modular chassis)
- Cisco Catalyst 9300 and 9300-L Series Switches
- Cisco Catalyst 9200 and 9200-L Series Switches

Distribution layer
The distribution layer supports many important services. In a network where connectivity needs to traverse the LAN end-to-end, whether between different access layer devices or from an access layer device to the

- **Scalability**—At any site with more than two or three access-layer devices, it is impractical to interconnect all access switches. The distribution layer serves as an aggregation point for multiple access-layer switc

The distribution layer can lower operating costs by making the network more efficient, by requiring less memory, by creating fault domains that compartmentalize failures or network changes, and by processing res

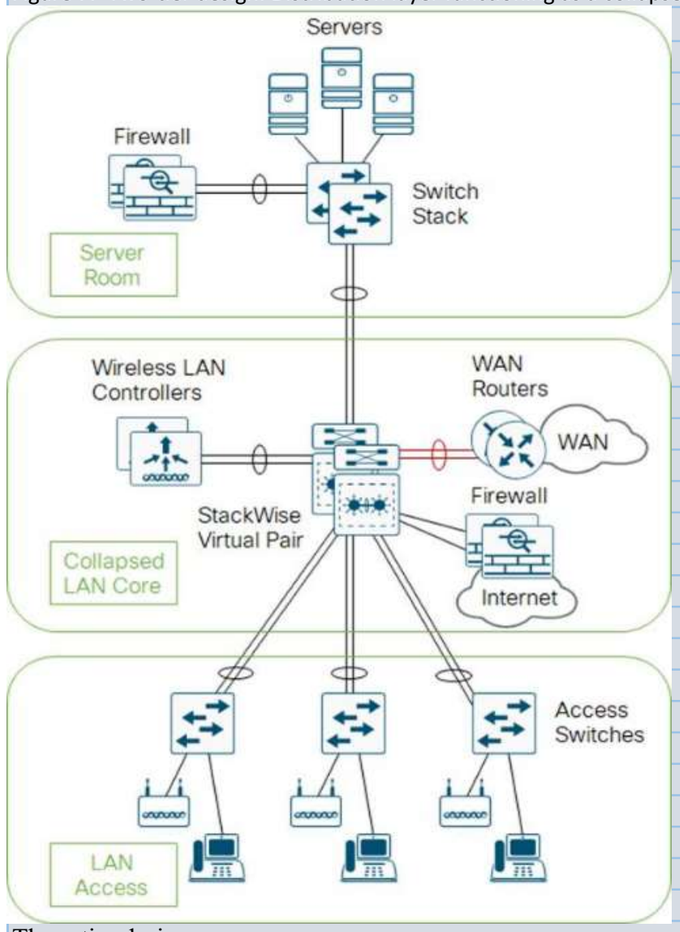
- **Reduce complexity and increase resiliency**—The campus wired LAN has the option to use a simplified distribution layer, in which a distribution-layer node consists of a single logical entity that can be implem

This approach reduces complexity of configuring and operating the distribution layer because fewer protocols are required. Little or no tuning is needed to provide near-second or sub-second convergence around fa

Two-tier design

The distribution layer provides connectivity to network-based services, to the WAN, and to the Internet edge. Network-based services can include and are not limited to Wide Area Application Services (WAAS) ar

Figure 7. Two-tier design: Distribution layer functioning as a collapsed core




Three-tier design

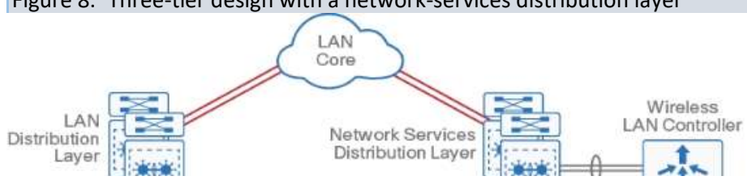
Larger LAN designs require a dedicated distribution layer for network-based services versus sharing connectivity with access layer devices. As the density of WAN routers, WAAS controllers, Internet edge devices

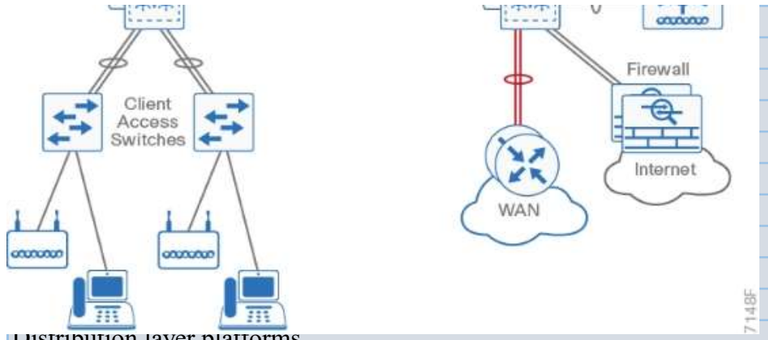
There are several factors that drive LAN design with multiple distribution layer modules:

- The number of ports and port bandwidth that the distribution layer platform can provide affects network performance and throughput.
- Network resilience is a factor when all LAN and network-based services rely on a single platform, regardless of that platform's design, it can present a single point of failure or an unacceptably large failure doma
- Change control and frequency affects resilience. When all LAN, WAN, and other network services are consolidated on a single distribution layer, operational or configuration errors can affect all network operati
- Geographic dispersion of the LAN access switches across many buildings in a larger campus facility would require more fiber optic interconnects back to a single collapsed core.

Like the access layer, the distribution layer also provides quality of service (QoS) for application flows to guarantee critical applications and multimedia applications perform as designed.

Figure 8. Three-tier design with a network-services distribution layer






Distribution layer platforms

The preferred Cisco switches for deploying the distribution layer of the campus wired LAN include:

- Cisco Catalyst 9600 Series Switches (modular chassis)
- Cisco Catalyst 9500 Series Switches
- Cisco Catalyst 9400 Series Switches (modular chassis)

Core layer

In a large LAN environment, there often arises a need to have multiple distribution layer switches. One reason for this is that when access layer switches are located in multiple geographically dispersed buildings, y

Another reason to use multiple distribution layer switches is when the number of access layer switches connecting to a single distribution layer exceeds the performance goals of the network designer. In a modular

In environments where multiple distribution layer switches exist in close proximity and where fiber optics provide the ability for high-bandwidth interconnectivity, a core layer reduces the network complexity to N

Figure 9. LAN topology with a core layer

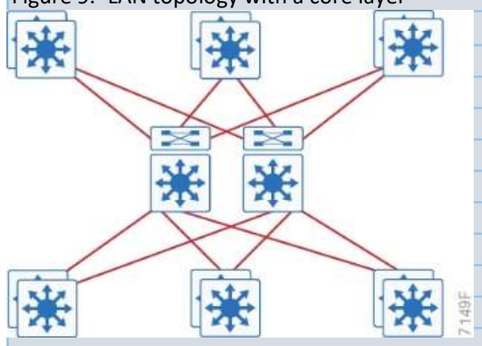
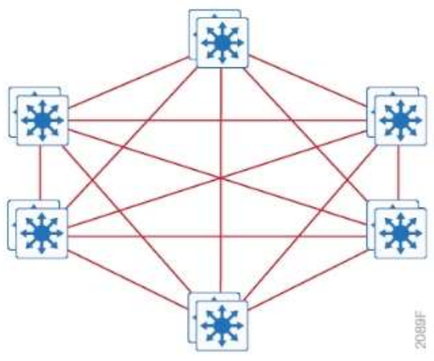



Figure 10. LAN topology without a core layer



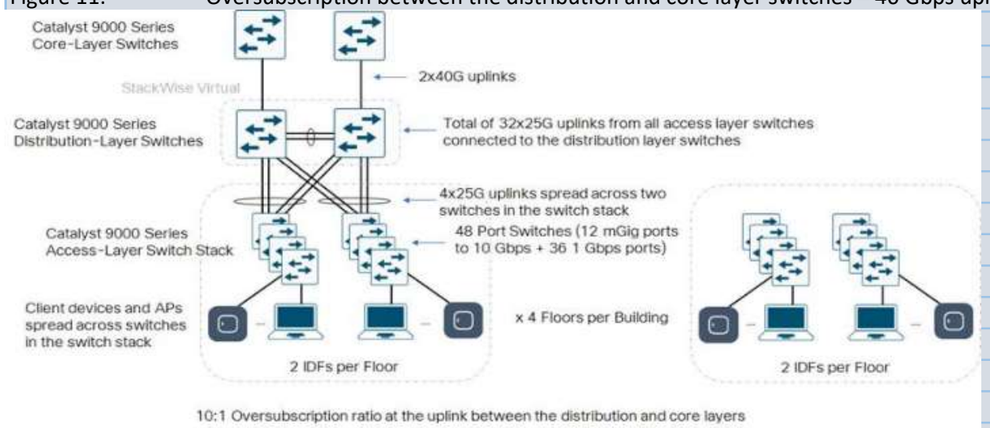

The core layer of the LAN is a critical part of the scalable network and, by design, is one of the simplest. The distribution layer provides the fault and control domains, and the core represents the 24x7x365 non-stop

Oversubscription ratios

For three-tiered designs, increasing the uplink speeds between the access and distribution layer switches may also require increasing uplink speeds between the distribution and core layer switches in order to mainta

Determining the oversubscription ratio of the uplink between the distribution and core layer switches is fairly straight forward. You need to take into consideration the number of ports connecting the distribution la

Figure 11. Oversubscription between the distribution and core layer switches – 40 Gbps uplinks


Catalyst 9000 Series
Core-Layer Switches
StackWise Virtual
2x40G uplinks
Catalyst 9000 Series
Distribution-Layer Switches
Total of 32x25G uplinks from all access layer switches
connected to the distribution layer switches
4x25G uplinks spread across two
switches in the switch stack
Catalyst 9000 Series
Access-Layer Switch Stack
48 Port Switches (12 mGig ports
to 10 Gbps + 36 1 Gbps ports)
Client devices and APs
spread across switches
in the switch stack
x 4 Floors per Building
2 IDFs per Floor
2 IDFs per Floor
10:1 Oversubscription ratio at the uplink between the distribution and core layers

For example, let's say your distribution layer switch is a StackWise Virtual pair that supports a building with 4 floors. Each floor has two IDFs (wiring closets). Each IDF has an access layer switch stack consistin

This configuration would provide up to 32 x 25 Gbps = 800 Gbps bandwidth between the distribution layer and access layer switches. Simply keeping existing 2 x 40 Gbps uplinks would only provide up to 80 Gb

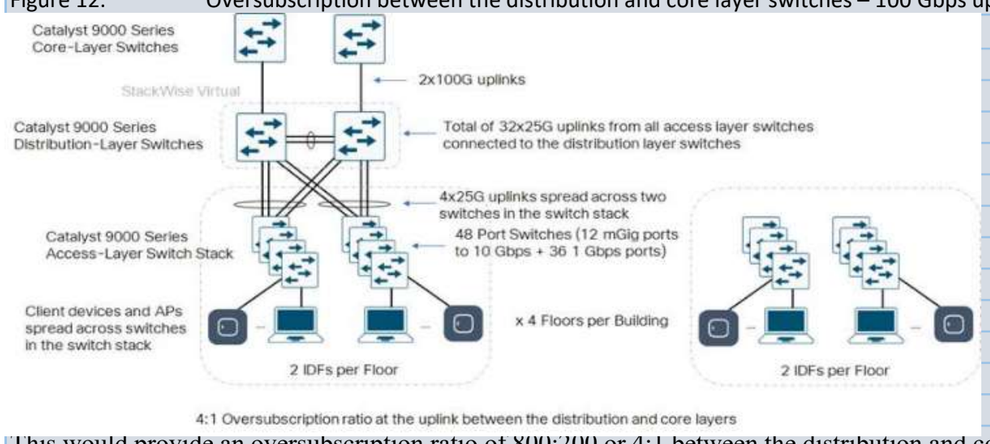
Increasing Uplink Speeds

You could choose to add additional 40 Gbps links between the distribution and core layer switches, possibly operating in a Layer 3 EtherChannel configuration. However, this would require additional 40 Gbps sw

In a large campus deployment, the core layer switches may be located in a centralized data center in a different building. If insufficient optical pairs exist, then additional optical cabling would need to be pulled bet

An alternative may be to upgrade the uplink speeds between the distribution layer and core layer switches to 100 Gbps.

Figure 12. Oversubscription between the distribution and core layer switches – 100 Gbps uplinks


Catalyst 9000 Series
Core-Layer Switches
StackWise Virtual
2x100G uplinks
Catalyst 9000 Series
Distribution-Layer Switches
Total of 32x25G uplinks from all access layer switches
connected to the distribution layer switches
4x25G uplinks spread across two
switches in the switch stack
Catalyst 9000 Series
Access-Layer Switch Stack
48 Port Switches (12 mGig ports
to 10 Gbps + 36 1 Gbps ports)
Client devices and APs
spread across switches
in the switch stack
x 4 Floors per Building
2 IDFs per Floor
2 IDFs per Floor
4:1 Oversubscription ratio at the uplink between the distribution and core layers

This would provide an oversubscription ratio of 800:200 or 4:1 between the distribution and core layers.

As with the access layer, when deciding to upgrade the uplink speeds between the distribution layer switches and the core layer switches, you should keep in mind the following:

- The optical transceiver modules which connect the distribution layer switches to the core layer switch platforms have to interoperate with each other and have to be compatible with the fiber optic cabling betwee

Due to the increased distances between buildings, single mode fiber (SMF) may already be installed between the distribution and core layer switches. This may help facilitate the migration from 40 Gbps to 100 Gb

Core layer platforms

The preferred Cisco switches used as campus platforms for the core layer are:

- Cisco Catalyst 9600 Series Switches (modular chassis)
- Cisco Catalyst 9500 Series Switches

The capacity, density, and features are the primary differences driving platform selection. Both lead platforms have sibling platforms that may be appropriate for the core role in existing networks or networks where

Design Options: Campus Wired LAN

When you scale from a single switch in a campus LAN up to a full three-tier campus network, the reliability of the network is increasingly important, because network downtime likely affects a greater user populat

The primary function of the distribution layer is to aggregate access layer switches in a given building or campus. The distribution layer provides a boundary between the Layer 2 domain of the access layer and the

Layer 2 access with traditional multilayer campus design

Traditional LAN designs use a multi-tier approach with Layer 2 from the access layer to the distribution layer, where the Layer 3 boundary exists. The connectivity from the access layer to the distribution layer can

In the traditional network design, the distribution layer has a pair of standalone switches for resiliency. It is recommended that you restrict a Layer 2 virtual LAN (VLAN) to a single wiring closet or access uplink p

To create a resilient IP gateway for VLANs in the traditional design, you must use first-hop redundancy protocols (FHRP), which provide hosts with a consistent MAC address and gateway IP for a VLAN. Hot star

**Note:** All FHRP protocols require that you fine-tune the default timer settings in order to allow for sub-second network convergence, which can impact switch CPU resources.

Some organizations require the same Layer 2 VLAN be extended to multiple access layer closets to accommodate an application or service. The looped design causes spanning tree to block links, which reduces the

Figure 13. Traditional looped design with VLANs spanning access switches

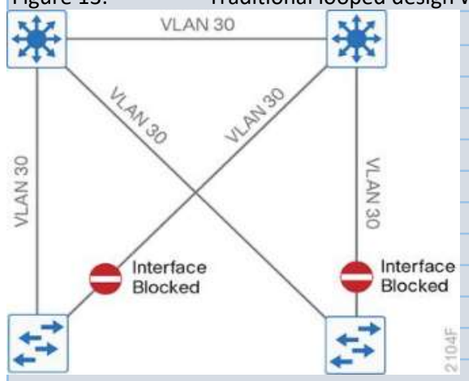
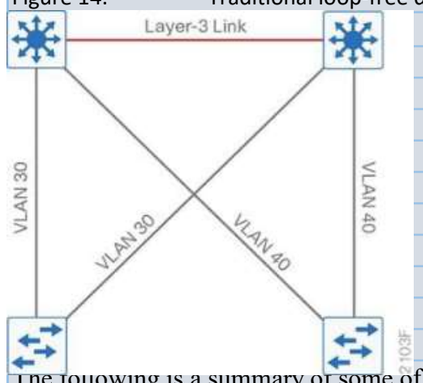



Figure 14. Traditional loop-free design with a VLAN per access switch




The following is a summary of some of design and operational concerns with the traditional multilayer campus design, driving alternative approaches:

- Spanning-tree protocol looping behavior, including blocked links, slow convergence, asymmetric forwarding, and switch CAM and ARP table tuning to address unicast flooding
- FHRP configuration consistency, slow convergence times driving protocol tuning in conflict with non-stop forwarding systems
- Layer 3 protocol tuning and protocol-dependent scale and recovery, multicast protocol configuration consistency and tuning, and general control plane, management, and forwarding complexity

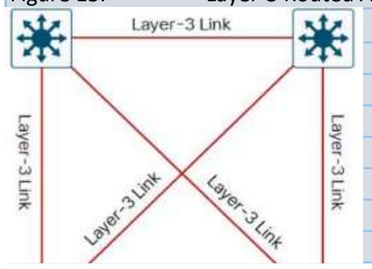
**Note:** The Flexlink+ feature of enables the user to configure a pair of a Layer 2 interfaces (trunk ports or port channels) where one interface is configured to act as a backup to the other. The feature provides an a

Because of the design and operational concerns inherent in the traditional multilayer campus design, organizations strive to deploy different designs, whenever possible.

Layer 3 routed access campus design

In another approach to access and distribution layer design, you can use Layer 3 beyond just the core and distribution layers and configure Layer 3 all the way into the access layer. Using the Layer 3 access design r

Figure 15. Layer-3 Routed Access



The challenges with the routed access layer design is that the Layer 2 domains are confined to a single access closet, which limits flexibility for applications that require Layer 2 connectivity that extends across mul
Preferred Layer 2 access using a simplified distribution layer campus design
An alternative that can handle Layer 2 access requirements and avoid the complexity of the traditional multilayer campus is called a Layer 2 access with simplified distribution layer design. The design uses multipl
Even in the distributed VLAN design, you eliminate spanning tree blocked links because of looped topologies. You reduce dependence on spanning tree by using EtherChannel to the access layer with dual-homed

Figure 16. Simplified distribution design with a VLAN per access switch

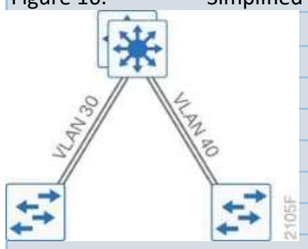
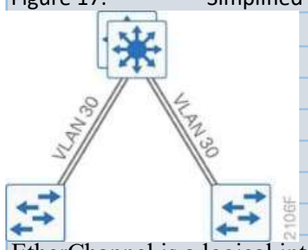
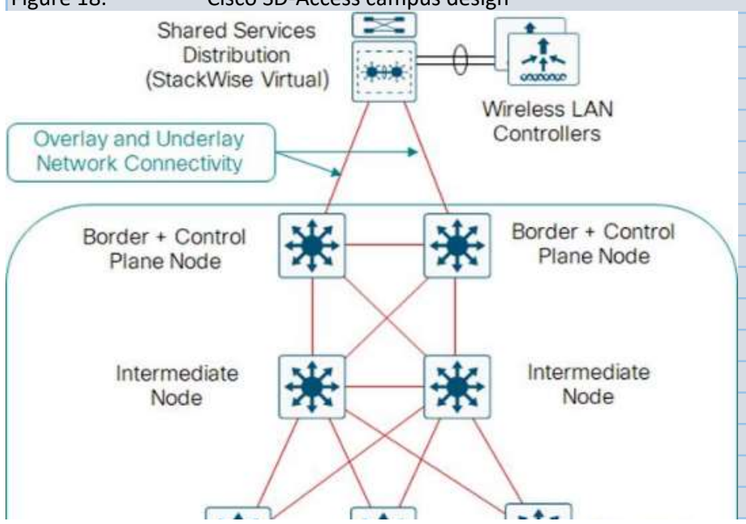


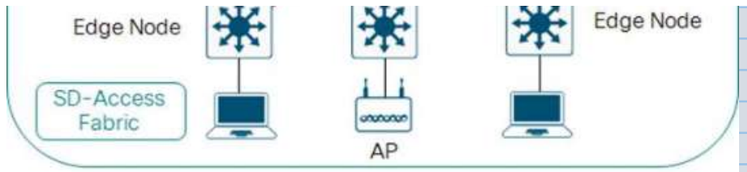

Figure 17. Simplified distribution design with VLANs spanning access switches




EtherChannel is a logical interface that can use a control plane protocol to manage the physical members of the bundle. It is better to run a dynamic channel protocol instead of using forced-on mode because a dyna
There are several other advantages to the simplified distribution layer design. You no longer need IP gateway redundancy protocols such as HSRP, VRRP, and GLBP, because the default IP gateway is now on a sin
The topology of the network from the distribution layer to the access layer is logically a hub-and-spoke topology, which reduces complexity of design and troubleshooting. The hub-and-spoke topology design provi
Finally, by using the single logical distribution layer design, there are fewer boxes to manage, which reduces the amount of time spent on ongoing provisioning and maintenance. Using the Cisco Catalyst 9000 Seri
Cisco Software-Defined Access campus design
Another way to overcome the Layer 2 adjacency restrictions while still maintaining the advantages of the routed access layer design is by adding fabric capability to a Layer 3 access campus network design, suppor
The addition of the fabric overlay is automated using Cisco DNA Center to deploy Cisco SD-Access technology. The Cisco SD-Access design enables the use of virtual networks (overlay networks, or macro segme

Figure 18. Cisco SD-Access campus design



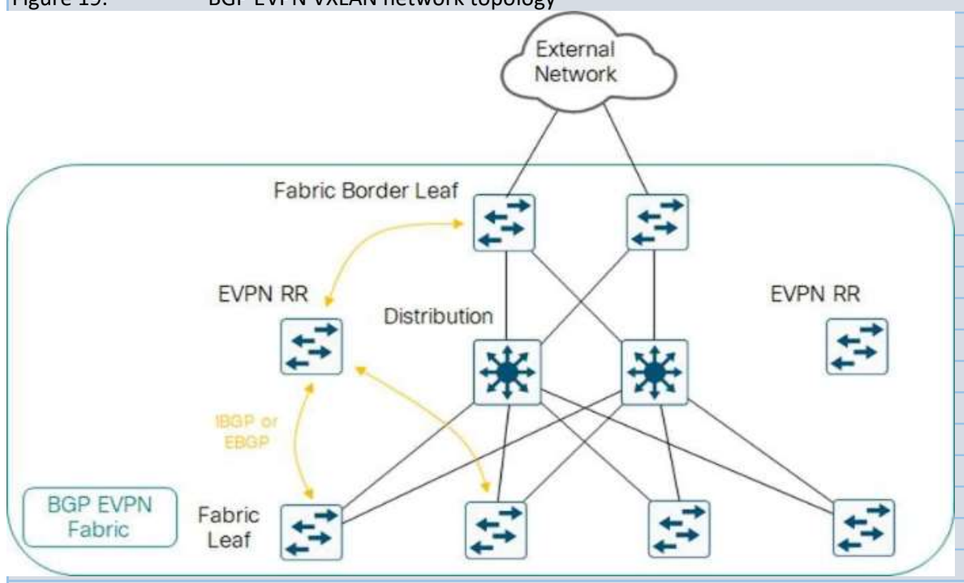



Beyond traditional network virtualization, Cisco SD-Access allows for software-defined segmentation and policy enforcement based on user identity and group membership, integrated with Cisco TrustSec technolo
For additional information, see the Software-Designed Access Solution Design Guide.

Alternative virtualization design for campus——BGP EVPN VXLAN

For organizations not requiring the full automation and assurance support for macro and micro segmentation policies integrated with wireless across the campus LAN, there are alternative multi-vendor options avai
Traditionally, multiprotocol label switching (MPLS) technology or basic segmentation using VRF-Lite has been adapted to campus networks to attempt to replicate service provider-like segmentation within the LA
Unlike Cisco SD-Access, the control plane protocol for creating forwarding tables is BGP, and scales using the well-known concept of route reflectors. However, EVPN does require greater Access (Leaf) and Bor

Figure 19. BGP EVPN VXLAN network topology




For organizations looking for an open standards-based overlay solution for their campus designs, and not needing the full intent-based networking security solution along with integrated wireless, BGP EVPN VXL

Design Fundamentals: LAN Security Best Practices

With any good network design, security must also be a focus. These tools below can help prevent attacks and make the network more secure and reliable.

**Note:** These are a few fundamental tools to help with basic network security, check out the Enterprise Security Design Guide for a more in depth look at campus security.

DHCP Snooping

Rogue DHCP servers can be detrimental to the security and usability of the network if not protected against properly. Rogue DHCP servers attack the network by assigning unrouteable IP addresses to clients causir
DHCP Snooping is a tool used to combat rogue DHCP servers. It works by assigning one or more ports as trusted, meaning these ports lead to legitimate DHCP servers. The switch will then build a database of the

Dynamic ARP Inspection

ARP cache poisoning is a malicious tool used to stage man-in-the middle attacks. It works by sending a forged ARP packet with the IP address of another device and the MAC address of itself to poison hosts ARP
Dynamic ARP Inspection (DAI) is a tool that can be used to mitigate this threat. DAI uses the DHCP snooping database for IP to MAC address bindings. DAI then intercepts all ARP packets and drops any packet v

BPDU Guard

In L2 networks, loops can be your worst nightmare. To combat this, we use STP (Spanning Tree Protocol), but this can also be used to hurt the network if we don't protect it.
In spanning tree, a root bridge is elected. This decides which ports will be put in a forwarding or blocking state. If a device is added with a lower priority than the current root bridge, it will take over causing a topol
BPDU guard is a protocol designed to solve this problem. When enabled, if a switch sees BDPU traffic coming from a port, it will automatically set it to the "errdisabled" state so that no traffic can pass.

802.1X

Authentication is very important for the security of the network. A potential attacker can sneak into a building and plug into an enabled network port and gain access to the network.

802.1X is an IEEE standard used for restricting unauthorized access to the network by making users authenticate before they are allowed onto the network. 802.1X uses three different parts for authentication.

- Supplicant – This is software which runs on the user device that collects credentials and forwards them to be authenticated.
- Authenticator – This is the network access device, usually a switch, the supplicant sends the user credentials to. The credentials are then forwarded to the authentication server.
- Authentication server – This is a RADIUS server that validates the credentials based off information in its database.

Cisco Umbrella

With remote workers and sites being more prevalent in today's networks, it can be difficult to secure the network from malware and phishing attacks.

Cisco Umbrella provides a first line of security for wherever users access the internet by using DNS as a security tool. Since DNS is a core part of the internet, it is used to block requests to malicious domains and I

Cisco Umbrella also provides network administrators visibility of Internet activity across all endpoint devices on or off the corporate network. This allows users to easily view any malicious domains or IP addresse

Design Fundamentals: LAN High Availability

To mitigate the concerns about unavailability of network resources, campus LAN designs include high availability / resiliency options, such as redundant links, switches, and switch components. Designing for high

Stateful Switchover (SSO)

Stateful switchover (SSO) synchronizes active process information, as well as configuration information, between active and standby supervisors of a modular chassis / StackWise Virtual pair, or between the active

Non-stop Forwarding (NSF)

Non-stop forwarding (NSF) helps to suppress routing flaps in SSO enabled devices. NSF allows for graceful restart of L3 routing protocols, in the event of the failure of the active supervisor of a modular chassis /

Supervisor Redundancy

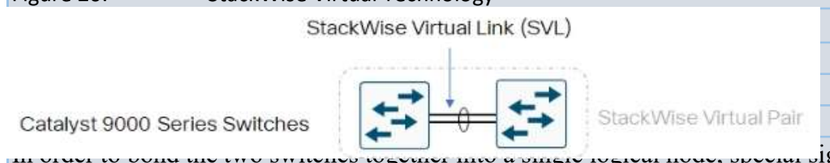
Cisco Catalyst C9404R, C9407R, C9410R, and C9606R chassis models support 1+1 supervisor redundancy (Sup-1, Sup1XL, or Sup-1XL-Y on Catalyst 9400 Series, and Sup-1 on Catalyst 9600 Series). The prima

**Note:** When implementing 1+1 supervisor engines on Catalyst 9400 Series switches, the active uplink ports are automatically spread across the two supervisors for link-level resiliency. The Catalyst 9600 Series

StackWise Virtual Technology

StackWise Virtual technology combines two Catalyst 9000 Series switches into a single logical network entity from the network control plane and management perspectives. Because the two switches operate as o

Figure 20. StackWise Virtual Technology




In order to bond the two switches together into a single logical node, special signaling and control information must be exchanged between the two switches. To facilitate this information exchange, a dedicated lin

Switch Stacks and Cisco StackWise Technology

Cisco StackWise technology allows up to a maximum of eight switches to be stacked together physically in a ring topology to form a single, unified, virtual stack system. The stacking architecture expands form fa

StackWise creates a unified control and management plane by electing one switch in the stack as the active switch and another switch as the hot-standby. Remaining switches become stack members. To logically

To optimally forward the traffic within the stack ring, the packet-stripping function is performed on the destination switch instead of on the source switch. This mechanism, known as the spatial-reuse forwarding m

The following sub-sections discuss the StackWise implementation on Catalyst 9200 and 9300 Series switches.

Catalyst 9200 Series StackWise-160/80

Catalyst 9200 Series switches enable stacking of up to 8 switches and 416 ports using a stack-ring fabric known as either StackWise-160 or StackWise-80. StackWise-160 is supported on Catalyst 9200 switch mo

Catalyst 9300 Series StackWise-480/360

Catalyst 9300 Series switches enable stacking of up to 8 switches and 448 ports using a stack-ring fabric known as either StackWise-480 or StackWise-360. StackWise-480 is supported on Catalyst 9300 switch m

EtherChannel

EtherChannel allows multiple physical Ethernet links to combine into one logical channel, allowing for load sharing of traffic among the links in the channel as well as redundancy in the event that one or more link

Software Maintenance Upgrades (SMUs)

An SMU is a software package that can be installed on Catalyst 9000 Series switches to provide a patch fix for bugs or security resolution to an already released image. The SMU type describes the effect the instal

**Note:** SMUs support patching using install mode only. SMUs are only supported on long-lived extended maintenance releases from IOS XE 16.6.1 on.

In-Service Software Upgrades (ISSUs)

In-Service Software Upgrade (ISSU) is a process that upgrades an image to another image on a device while the network continues to forward packets. ISSU helps network administrators avoid a network outage w

**Note:** ISSU is not supported for an upgrade from Cisco IOS XE Fuji 16.9.1 to Cisco IOS XE Fuji 16.9.2. ISSU from Cisco IOS XE Fuji 16.9.x to Cisco IOS XE Gibraltar 16.10.x or Cisco IOS XE Gibraltar 16.

Graceful Insertion and Removal (GIR)

GIR leverages redundant paths and existing routing protocols to gracefully isolate a device without impacting active flows. Conversely, GIR also gracefully reinserts the device back into service when the work is co

Fast Software Upgrade (FSU) and Extended Fast Software Upgrade

During a software upgrade on the switch, user traffic is disrupted until the new software completely boots up. The traffic downtime is a concern for customers running critical applications. The Fast Software Upgra

**Note:** Fast software upgrade is supported only on access switches with a single logical uplink connection. Fast software upgrade is not supported if the Micro Controller Unit (MCU) Field Programmable Gate Ar

Extended Fast Software Upgrade reduces the traffic downtime during software reload or upgrade operations. Compared to Fast Software Upgrade, the traffic downtime is reduced to less than 30 seconds, depending

The following table summarizes high availability support with the various Catalyst 9000 Series switches.

**Table 1.** High availability feature support

| Platform | Switch Stacking | Supervisor Redundancy | NSF / SSO | EtherChannel | ISSU | SMUs | GIR | Power Redundancy | |
|---|---|---|---|---|---|---|---|---|---|
| Cisco Catalyst 9200 Series | StackWise-160/80 with Active / Standby | — | Yes | Cross-Stack EtherChannel | No | Yes | No | Up to 2 hot-swappable power supplies per switch. PoE models operate in Combined mode. Non-PoE models operate in 1:1 redundancy mode. | |
| Cisco Catalyst 9300 Series | StackWise-480/360 with Active / Standby | — | Yes | Cross-Stack EtherChannel | No. Supports Fast Software Upgrade (FSU) and Extended FSU. | Yes | Yes | StackPower (up to 4 switches per stack) operating in shared or redundant mode. Cisco XPS 2200 for stacks of up to 8 switches | |

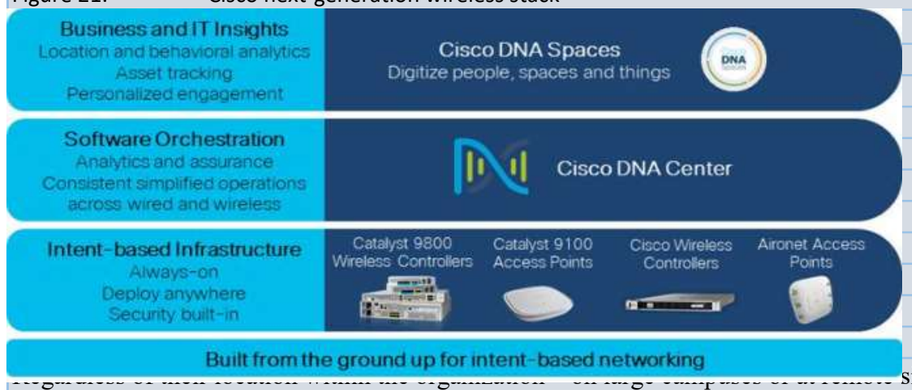
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Cisco Catalyst 9400 Series | — | Single chassis 1:1 or cross chassis StackWise Virtual | Yes | Multichassis EtherChannel with StackWise Virtual | Yes | Yes | Yes | Hot-swappable power supplies in N+N or N+1 power redundancy modes | |
| Cisco Catalyst 9500 Series | — | Cross chassis StackWise Virtual | Yes | Multichassis EtherChannel with StackWise Virtual | Yes | Yes | Yes | Dual 1+1 redundant power supplies. | |
| Cisco Catalyst 9600 Series | — | Single chassis 1:1 or cross chassis StackWise Virtual | Yes | Multichassis EtherChannel with StackWise Virtual | Yes | Yes | Yes | Four power supplies which can operate in Combined or N+1 redundancy modes. | |

Design Fundamentals: Campus Wireless LAN

The campus WLAN provides ubiquitous data and voice connectivity for employees, wireless Internet access for guests, and connectivity for IoT devices. With the emergence of high-density networks and the IoT, c

Cisco wireless solutions are resilient, have the integrated security organizations need, and employ adaptive and insightful intelligence providing useful insight into the network. With intent-based networking built o

Figure 21. Cisco next-generation wireless stack




regardless of their location within the organization—on large campuses or at remote sites—wireless users have the same experience when connecting to voice, video, and data services.

Infrastructure

The next-generation wireless stack is built around these main hardware and software components:

- Cisco Catalyst 9800 Series WLAN controllers (including appliances, virtual, and embedded)
- Cisco Catalyst 9100 Wi-Fi 6 APs

- Cisco DNA Center (assurance and automation)
- Cisco Prime Infrastructure (additional automation for more complex deployments)
- Cisco DNA Spaces

Cisco Catalyst 9800 Series wireless controllers

Cisco Catalyst 9800 Series wireless controllers combine RF excellence with Cisco IOS-XE benefits. These highly reliable and highly secure controllers are ready to deploy anywhere—including the cloud. An organization can also choose the Cisco Embedd

Cisco Catalyst 9800 Series wireless controllers are built on the three pillars of network excellence—always on, secure, and intelligent—which strengthen the network by providing the best wireless experience without compromise, while saving time and mor

- **Always on**—Seamless software updates enable faster resolution of critical issues, introduction of new APs with zero downtime, and flexible software upgrades. High availability stateful switchover (HA SSO), d
- **Secure**—Secure air, devices, and users with Cisco Catalyst 9800 Series wireless controllers. Wireless infrastructure becomes the strongest first line of defense with ETA and Cisco SD-Access. The controller cor
- **Intelligent**—Cisco Catalyst 9800 Series wireless controllers are built on the modular Cisco IOS XE operating system, which offers a rich set of open standards-based programmable APIs and model-driven telem

Cisco WLAN controllers are responsible for system-wide WLAN functions, such as security policies, intrusion prevention, RF management, QoS, and mobility. They work in conjunction with Cisco APs in order t

The following table summarizes the Cisco WLAN controllers referenced within this guide.

**Table 2.** WLAN controller platforms

| Platform | Deployment Mode | Preferred Topology | Maximum APs | Maximum Clients | Controller Throughput |
|---|---|---|---|---|---|
| Cisco Catalyst 9800-80 | Centralized, | Large Campus | 6,000 | 64,000 | Up to 80 Gbps |
| | FlexConnect, | | | | |
| | or SD-Access | | | | |
| Cisco Catalyst 9800-40 | Centralized, | Medium Campus | 2,000 | 32,000 | Up to 40 Gbps |
| | FlexConnect, | | | | |
| | or SD-Access | | | | |
| Cisco Catalyst 9800-L | Centralized, | Small Campus / Remote Site | 250 | 5,000 | Up to 5 Gbps |
| | FlexConnect, | | | | |
| | or SD-Access | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Cisco Catalyst 9800-L with Performance License | Centralized, | Small Campus / Remote Site | 500 | 10,000 | Up to 9 Gbps | |
| | FlexConnect, | | | | | |
| | or SD-Access | | | | | |
| Cisco Catalyst 9800 embedded on Cisco Catalyst 9000 Series Switches | SD-Access | SD-Access Small Distributed Site | 200 | 4,000 | — | |
| | | | | | (local switching) | |
| Cisco Catalyst 9800 Embedded on Catalyst 9100 Series Access Points (EWC) | Local Switching | Small Remote Site | 100 | 2,000 | — | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | (local switching) | |
| Cisco Catalyst 9800-CL for | FlexConnect with Local Switching | Virtual Controller for Small Remote Sites | 1,000, | 10,000, | — | |
| Public Cloud | | | 3,000, or | 32,000, or | (local switching) | |
| | | | 6,000 | 64,000 | | |
| Cisco Catalyst 9800-CL for Private Cloud | Centralized, | Virtual controller for Small, Medium, or Large Sites | 1,000, | 10,000, | Up to 2.1 Gbps with Central Switching (IOS XE 17.1 and higher) | |
| | FlexConnect, | | 3,000 (central), or | 32,000 (central), or | | |
| | or SD-Access | | 6,000 (FlexConnect) | 64,000 (FlexConnect) | | |

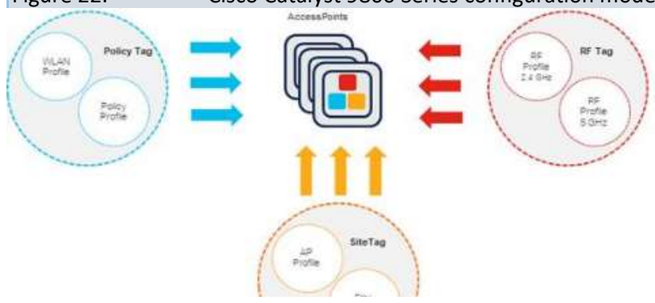
Additional scale numbers, including maximum Site Tags, Flex APs per site, Policy Tags, RF tags, RF Profiles, Policy Profiles, and Flex Profiles can be found in the datasheets of individual wireless controller platf

Because software license flexibility allows you to add additional APs when requirements of an organization change, you can choose the controller that will support your needs long term, but you purchase increment

Cisco Catalyst 9800 Series configuration model

The Cisco Catalyst 9800 Series wireless controller configuration data model is based on design principles of reusability, simplified provisioning, enhanced flexibility and modularization to help manage networks as

Figure 22. Cisco Catalyst 9800 Series configuration model



Wireless clients and APs derive their configurations from the profiles contained within the tags. The properties of a tag are defined by the policies defined within profiles associated with the tag. Profiles represent

Policy tags

Policy tags define the broadcast domain (list of WLANs to be broadcast) within the policies of the respective SSIDs. For ease of deployment, tags can be assigned based on location and filter, as opposed to staticall

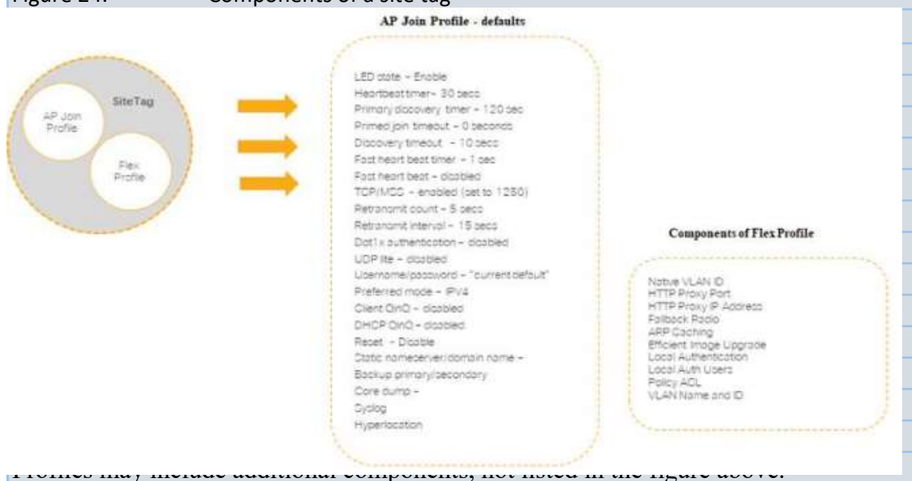
Figure 23. Components of a policy tag

Profiles may include additional components, not listed in the figure above.

Site tags

Site tags define the properties of the central and remote sites. They also define the roaming domain for Cisco FlexConnect APs in a Cisco FlexConnect deployment. Site tags are associated with an AP Join Profile

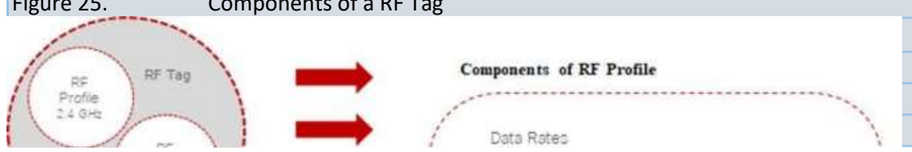
Figure 24. Components of a site tag




RF tags

RF tags define the properties of the group of APs. RF tags are associated with a 2.4 GHz RF Profile and a 5 GHz RF Profile - with their respective attributes shown in the figure below.

Figure 25. Components of a RF Tag



Profiles may include additional components, not listed in the figure above.

Cisco Catalyst 9800 Series wireless controller configuration can be managed using Cisco DNA Center, NETCONF/YANG, Cisco Prime Infrastructure, the web-based graphical user interface (GUI), or the comman

Cisco Catalyst 9100 Series APs

Cisco Catalyst 9100 Series APs can handle the challenges of the next-generation network. Going beyond the Wi-Fi 6 (802.11ax) standard, Cisco Catalyst 9100 Series APs are resilient and intelligent and provide integrated security for mobile clients and IoT

- **Wi-Fi 6 and beyond—**Wi-Fi 6 reduces latency and increases capacity for demanding applications on more devices. Cisco improves on it with programmable RF ASICs. We advance more wireless efficiency wi
- **Addresses IoT expansion—**The Cisco Catalyst 9100 Series offers multilingual support and application hosting of IoT protocols. In addition, IoT devices (as well as user devices) can see up to three times less e
- **Investment protection with multigigabit—**The Cisco Catalyst 9100 Series supports NBASE-T and IEEE 802.3bz Ethernet compatibility to seamlessly offload network traffic without bottlenecks. With Cisco C
- **Available with embedded control—**You can choose an option that is easy to deploy and manage and doesn't require a physical appliance. Cisco Catalyst 9800 Embedded Wireless Controller (EWC) can be buil

The following table summarizes the APs discussed within this guide.

**Table 3.** Cisco Aironet APs

| | Cisco Catalyst 9115AX | Cisco Catalyst 9117AX | Cisco Catalyst 9120AX | Cisco Catalyst 9130AX |
|---|---|---|---|---|
| Best for | Small to medium deployments | Small to medium deployments | Mission critical, high density, large size networks | Best in class, high density, large size networks |

| | | | | | |
|---|---|---|---|---|---|
| Features | Wi-Fi 6 (802.11ax), OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Apple Features | Wi-Fi 6 (802.11ax), OFDMA, MU-MIMO, Target Wake Time (TWT), Apple Features | Wi-Fi 6 (802.11ax), Cisco RF ASIC, Uplink/Downlink OFDMA, MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | Wi-Fi 6 (802.11ax) certified, Cisco RF ASIC, Uplink/Downlink OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | |
| Radios | Three radios: 2.4 GHz (4x4), 5 GHz (4x4), and BLE | Three radios: 2.4 GHz (4x4), 5 GHz (8x8), and BLE | Four radios: 2.4 GHz (4x4), 5 GHz (4x4), Cisco RF ASIC, and BLE/IoT* | Four radios: 2.4 GHz (4x4), 5 GHz (8x8 and 4x4), Cisco RF ASIC, and BLE/IoT* | |
| Antennas | Internal and external | Internal | Internal and external | Internal and external | |

| | | | | |
|---|---|---|---|---|
| Support for Cisco Catalyst 9800 Embedded (EWC) | Yes | Yes | Yes | Yes |
| Multigigabit Ethernet Support | Yes | Yes | Yes | Yes |
| HDX Support | No | No | Yes | Yes |
| Cisco CleanAir Technology | No | No | Yes | Yes |
| Flexible Radio Assignment | No | No | Yes | Yes |
| Combined Data Rate | Up to 5 Gbps | Up to 5 Gbps | Up to 5 Gbps | Up to 5 Gbps |

* Radio available for future use

Support for two key technologies differentiates the APs selected for deployment in the campus WLAN:

- **802.11ax (Wi-Fi 6)**—The IEEE 802.11ax (Wi-Fi 6) specification provides for significant enhancements to wireless networking performance including the following:
  - Higher capacity: Attach more devices than under previous standards through features such as orthogonal frequency-division multiple access (OFDMA) and multiuser multiple-input multiple-output (MU-MIMO)
  - Improved power efficiency: Using target wake time (TWT), client devices that support the Wi-Fi 6 standard may consume less power. This means that batteries in products such as smartphones, laptops, tablets,
  - Reduced data latency by optimizing packet scheduling, which is ideal for voice, video and gaming applications.
  - Greater IoT coverage by bringing the benefits of Wi-Fi 6 to the 2.4- GHz band.
  - Increased speed: Gain an increase in average throughput in congested wireless environments.
  - Improved security: WPA3 is certified with Wi-Fi 6 and provides a greater value proposition than WPA2 for enterprise Wi-Fi networks. It offers enhanced security for open Wi-Fi networks with encryption of una
- **Cisco RF ASIC**—The custom Cisco RF ASIC, available within the Cisco Catalyst 9120AX and 9130AX Series APs, provides enhanced off-channel monitoring, improving serving radio performance by as muc

Cisco DNA Spaces

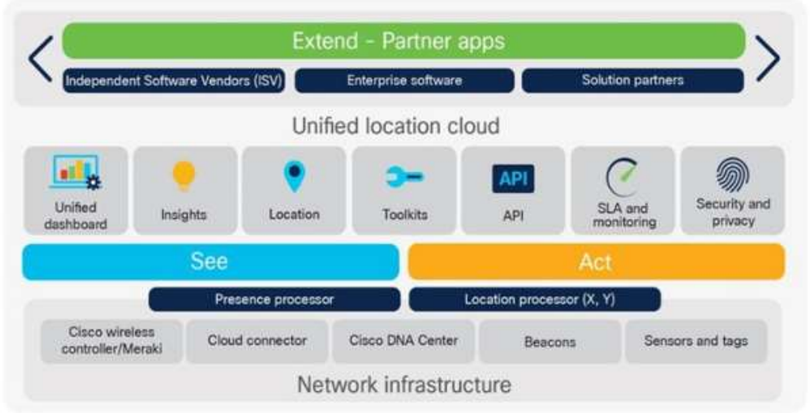
Cisco DNA Spaces provides organizations with rich location-based wireless services, including location analytics, business, insights, customer engagement toolkits, asset management, enterprise integrations, and l

With Cisco DNA Spaces you gain the following benefits:

- **Simplification**: A single, unified platform for accessing location products and apps and for normalizing data to create meaningful insights
- **Cloud first, scalable**: A cloud-first software-as-a-service (SaaS) approach that enables presence and location connection to the cloud across the entire installed base
- **Standardization**: Compatibility and interoperability across all Cisco wireless—Cisco Aironet, Cisco Catalyst, and Cisco Meraki
- **Support**: 24x7 monitoring and service-level agreements (SLAs) for end-to-end reliability
- **Low touch**: No need to upgrade your underlying network infrastructure to activate service

Cisco DNA Spaces takes the wireless network beyond connectivity to drive digitization in three easy steps: See, Act, and Extend.

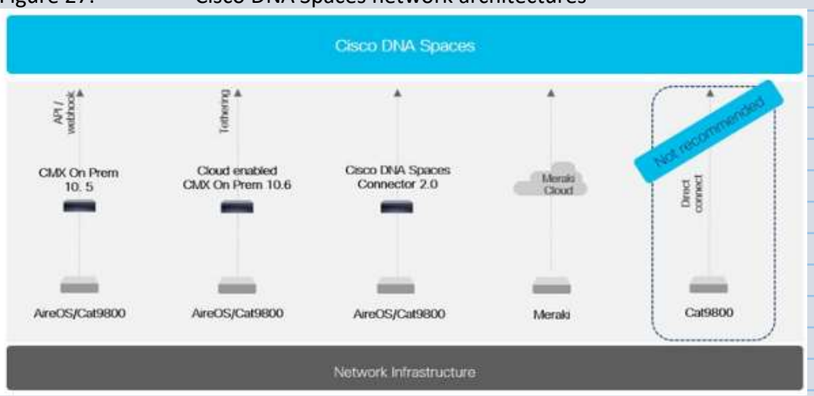
Figure 26. Cisco DNA Spaces




Now you can see what's happening at your properties, act on this knowledge through digitization toolkits, and extend platform capabilities by leveraging a partner app ecosystem.

Cisco DNA Spaces provides support for all wireless deployment modes.

Figure 27. Cisco DNA Spaces network architectures




An on premises deployment of Cisco DNA Spaces is required for the following:

- **Hyperlocation**—To use the Cisco Aironet 4800 Series or 3700 Series APs with a hyperlocation antenna, or to use fast path on all APs on an on-premises server, it is required to receive fast path UDP data on po
- **Integration with Cisco DNA Center or Prime Infrastructure**—To provide location data to Cisco DNA Center or Prime Infrastructure, an on-premise server is currently required.

Wireless design models

This guide describes the following design models and their recommended use:

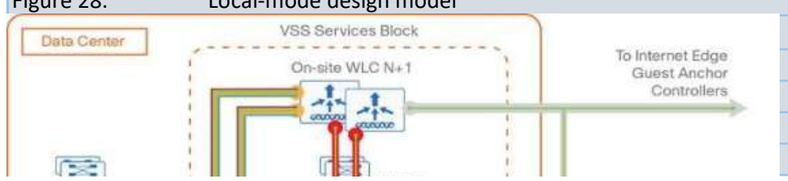
- Centralized (local-mode) design model
- Cisco FlexConnect design model
- Cisco SD-Access Wireless design model
- Cisco Catalyst 9800 Embedded on Catalyst 9100 Series APs (EWC) design model

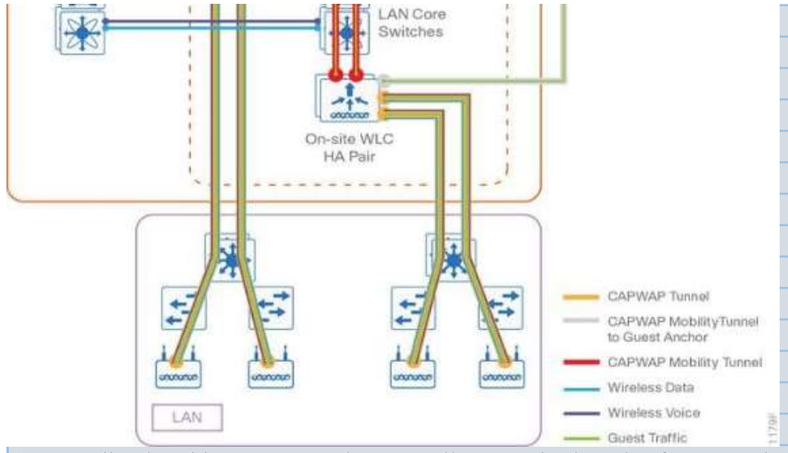
Centralized (local-mode) design model

A centralized design model, also known as a local-mode design model, is recommended primarily for large site deployments. The benefits of a centralized design include IP address management, simplified configu

You can connect the WLAN controller to a data center services block, a separate services block off of the campus core, or a LAN distribution layer. Wireless traffic between WLAN clients and the LAN is tunneled

Figure 28. Local-mode design model






A centralized architecture uses the controller as a single point for managing Layer 2 security and wireless network policies. It also enables services to be applied to wired and wireless traffic in a consistent and coor

The local-mode design model meets the following organization demands:

- **Seamless mobility**—Enables fast roaming across the campus, so that users remain connected to their session even while walking between various floors or adjacent buildings with changing subnets
- **Ability to support rich media**—Enhances robustness of voice with call admission control and multicast with Cisco VideoStream technology
- **Centralized policy**—Enables intelligent inspection through the use of firewalls, as well as application inspection, network access control, policy enforcement, and accurate traffic classification

If *any* of the following are true at a site, you should consider deploying a controller locally at the site:

- The site has a data center.
- The site has a LAN distribution layer.
- The site has more than 100 APs.
- The site has a WAN latency greater than 100ms round-trip to a proposed shared controller.

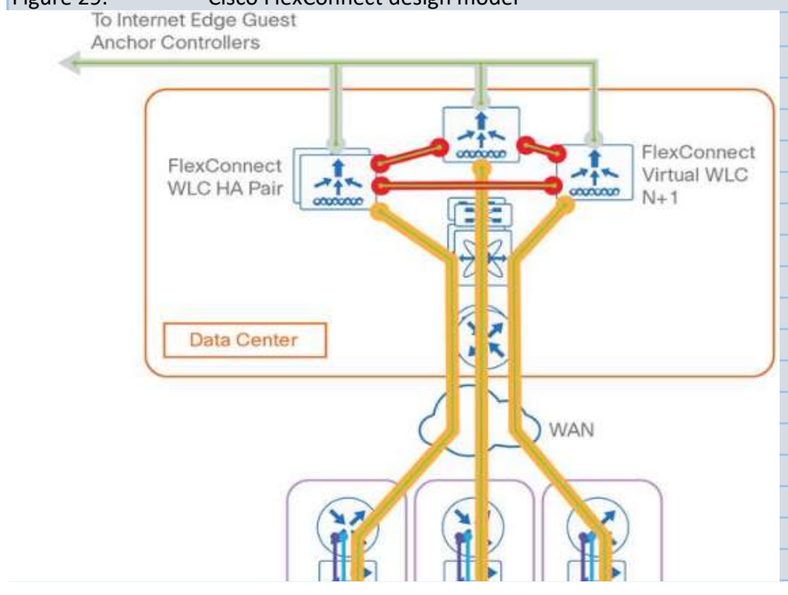
The recommended platforms for large centralized (local-mode) designs are the Cisco Catalyst 9800-80 and 9800-40 WLAN controllers, because of their scalability and feature support. For smaller sites, you can de

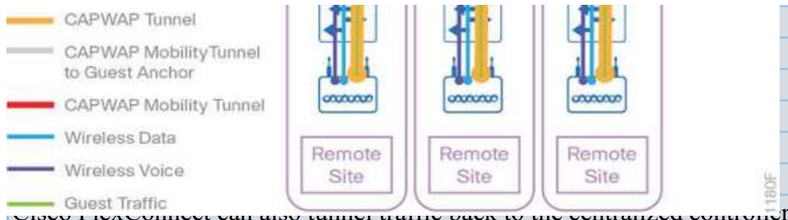
Cisco FlexConnect design model

Cisco FlexConnect is a wireless solution primarily for deployments that consist of multiple small remote sites (branches) connected into a central site. Cisco FlexConnect provides a highly cost-effective solution, e

Cisco APs operating in Cisco FlexConnect mode can switch client data traffic out their local wired interface and can use 802.1Q trunks in order to segment multiple WLANs. The trunk's native VLAN is used for a

Figure 29. Cisco FlexConnect design model






Cisco FlexConnect can also tunnel traffic back to the centralized controller, which can be used for wireless guest access. You can use a shared controller pair or a dedicated controller pair in order to deploy Cisco F

In a shared controller model, both local-mode and Cisco FlexConnect configured APs share a common controller. A shared controller architecture requires that the WLAN controller support both Cisco FlexConnec

You may be able to use a shared deployment if you meet all the following requirements:

- You have an existing local-mode controller pair at the same site as your WAN aggregation.
- The controller pair has enough additional capacity to support the Cisco FlexConnect APs.
- The number of site tags with Cisco FlexConnect profiles required matches the capabilities of the controller pair.

If you don't meet the requirements for a shared controller, you can deploy dedicated Cisco Catalyst 9800-80, 9800-40, or 9800-L Series wireless controllers. The Cisco Catalyst 9800-CL virtual form factor, deploye

For highest resiliency, deploy a pair of controllers in HA SSO configuration. Alternatively, you can deploy N+1 high availability in order to provide cross-site resiliency if desired. With N+1 HA, APs are configure

If all of the following are true at a site, you should consider deploying Cisco FlexConnect at the site:

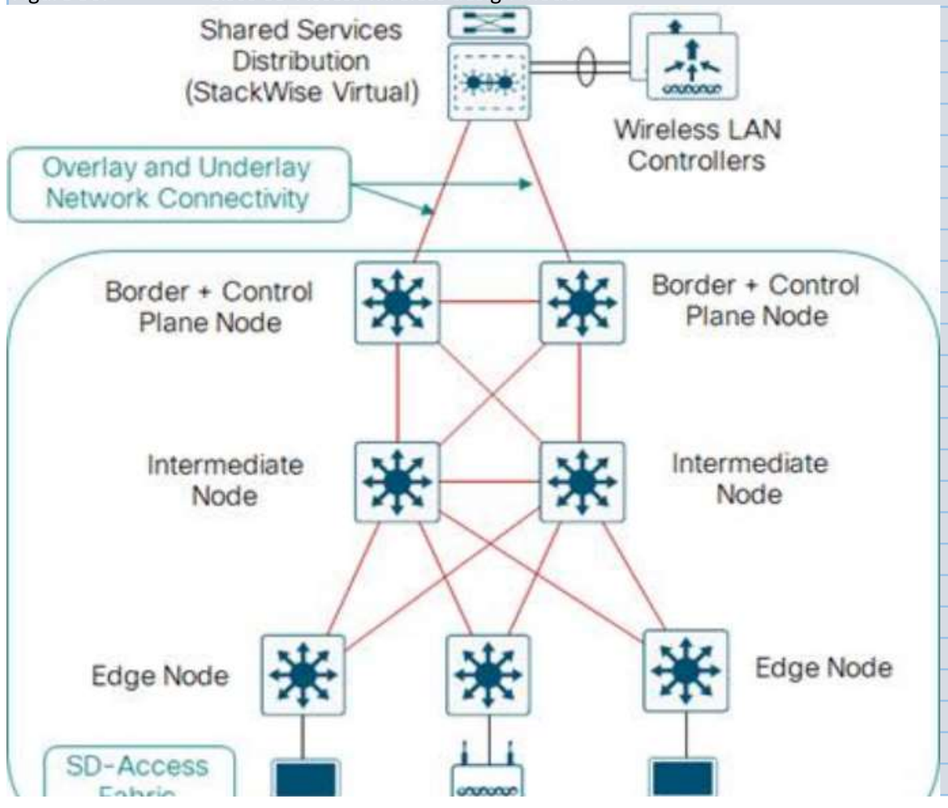
- The site LAN is a single access-layer switch or switch stack.
- The site has fewer than 50 APs.
- The site is one of many small remote sites connected to a central location
- The site has a WAN latency less than 100ms round-trip to the shared controller.

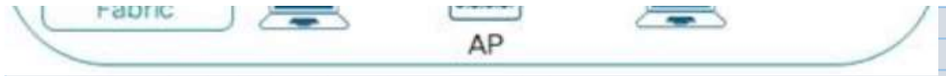
Cisco SD-Access Wireless design model

Cisco SD-Access Wireless is the fabric-enabled wireless solution that, unlike any alternative solution, fully integrates with a wired Cisco SD-Access model. The primary benefit of Cisco SD-Access Wireless is tha

**Note:** SD-Access Wireless control plane traffic is passed to the WLC, while data plane traffic is passed directly into the fabric. The distributed data plane allows the solution to scale more easily, avoids hair-pin

Figure 30. Cisco SD-Access wireless design model





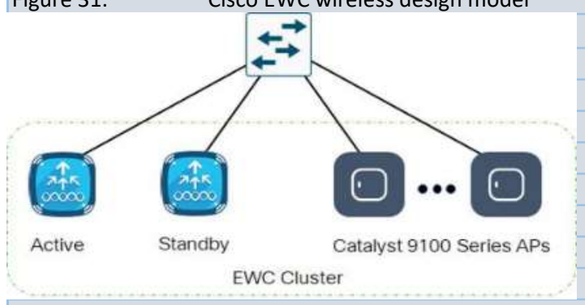

Requirements for deploying Cisco SD-Access Wireless:

- Cisco SD-Access wired fabric deployment
- APs with fabric mode support directly connected to Cisco SD-Access fabric edge nodes
- WLC with fabric mode control plane support
- 20ms or less latency between the fabric APs and the fabric WLC
- Cisco SD-Access Wireless design model

Cisco Catalyst 9800 Embedded on Catalyst 9100 Series APs (EWC) wireless design model

The Cisco EWC is a Wi-Fi solution using a Cisco Catalyst 9800 Series Wireless Controller embedded into the Cisco Catalyst 9100 Series APs. The Cisco EWC is an alternative to Cisco FlexConnect deployments

Figure 31. Cisco EWC wireless design model




The Cisco EWC platform provides the following benefits:

- High availability with active and standby controllers running simultaneously on two Cisco Catalyst 9100 Series APs (configuration synchronization, not HA SSO)
- Software maintenance updates (SMUs) providing hot patching of the controller, AP device packs, and AP service packs supported, like standalone controllers
- Cisco DNA Center support for Plug and Play, Automation, and Assurance, including Intelligent Capture (similar to other deployment models)
- Advanced RF features such as Flexible Radio Assignment (FRA) and Cisco CleanAir technology (similar to other deployment models)
- Automatic configuration of wireless best practices from more than 10 years of experience with large and medium-scale implementations

If the following are true, you should consider deploying the EWC at the site:

- Single site or multisite enterprise locations with up to 100 APs and 2,000 clients per site for Cisco Catalyst 9120AX or 9130AX Series running EWC; or up to 50 APs and 1,000 clients per site for Cisco Catalyst
- Guest Anchor is not required (currently not supported on the EWC).
- Layer 2 roaming only, without mobility groups.

**Note:** Cisco 802.11ac Wave 2 APs can join a Cisco EWC network and service clients, but Cisco 802.11ac Wave 2 APs cannot run the EWC function.

Design Options: Campus Wireless LAN

AP site tag considerations

Cisco Catalyst 9800 Series wireless LAN controllers have a multi-process architecture. Multiple wireless network controller processes (WNCd) run within a single Cisco Catalyst 9800 platform. The number of W

APs (and wireless clients) are load balanced across the WNCd instances for better scale and performance. In recent software releases, APs are load balanced across the WNCd instances based upon the site tag appl

Roaming and fast roaming work across site tags. However, 802.11k assisted roaming, 802.11v BSS transition, coverage hole detection (CHD), and other proximity based features are managed within individual W

The following are recommendations based on specific deployments:

- If the deployment has a building with more than 400 APs, consider splitting the building into two parts from site tag perspective. Each part should have its own custom site tag with less than 400 APs.

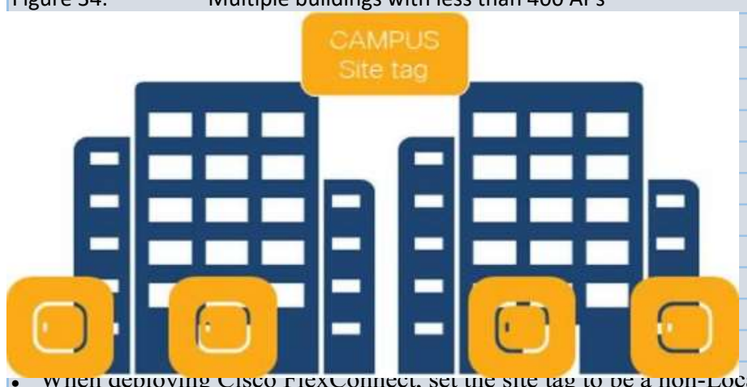
Figure 32. Single building with more than 400 APs

- If the deployment has a roaming domain that spans across multiple buildings, with more than 400 APs, consider configuring a Site Tag per building.

Figure 33. Multiple buildings with more than 400 APs

- If the deployment has multiple buildings, with less than 400 APs, consider configuring a single custom site tag. Don't use the default site tag.

Figure 34. Multiple buildings with less than 400 APs




- When deploying Cisco FlexConnect, set the site tag to be a non-Local Site within the Cisco Catalyst 9800 configuration. When the Local Site option is disabled, the site tag is equivalent to a Cisco FlexConnect

Figure 35. Site Tags for Cisco FlexConnect APs

There is a limit of 100 APs per Cisco FlexConnect site tag for seamless roaming. Roaming across site tags for Cisco FlexConnect APs results in a client full reauthentication.

High availability

As more devices with critical functions move to the wireless medium, high availability of the wireless infrastructure is becoming increasingly important. Real-time audio, video, and text communication relies on th

Designing for high availability must also consider the entire lifecycle of the deployment, including the need for updates and upgrades on the network. This section also discusses the use of software maintenance up

The methods of high availability discussed within this design guide, available with releases of Cisco IOS-XE 17.1 and higher, are as follows:

- High availability SSO
- N+1 high availability
- WLAN controller link aggregation
- Wireless controller patches using software maintenance updates (SMUs)
- AP patches using AP service packs (APSPs)
- Support for new AP models using AP device packs (APDPs)

High availability stateful switchover (HA SSO)

Cisco wireless LAN controllers support AP stateful switchover and client stateful switchover. These two features are collectively referred to as HA SSO. For both simplicity and efficacy, HA SSO is the preferred o

The configuration and software upgrades of the primary WLAN controller are automatically synchronized to the resilient standby WLAN controller.

N+1 high availability

You can use the N+1 HA architecture in order to provide redundancy for WLAN controllers within a single site or across geographically separate sites with lower overall cost of deployment. It is often deployed al

With N+1 HA, WLAN controllers are independent of each other and do not share configuration or IP addresses on any of their interfaces. Each WLC must be managed separately, can run different hardware, and c

It is recommended (but not required) that you run the same software version across WLCs used for N+1 HA, in order to reduce downtime as the APs establish CAPWAP sessions to the backup controllers. You ca

WLAN controller link aggregation

Cisco wireless controller appliances have multiple physical Ethernet ports. In typical deployments, one or more WLANs/service set identifiers (SSIDs) are mapped to a VLAN interface, which is then mapped to a p

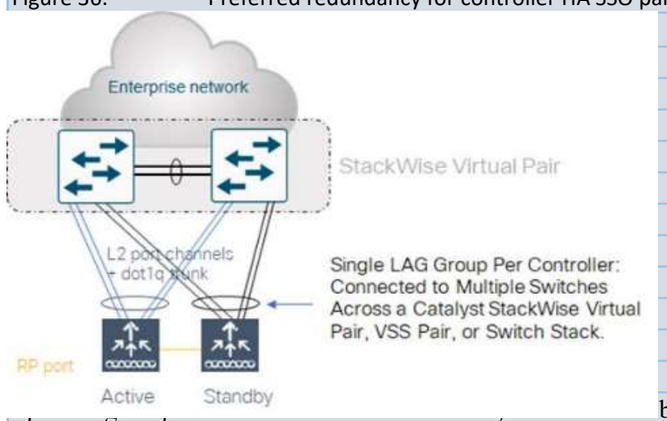
When LAG is enabled, the wireless controller dynamically manages port redundancy and load-balances APs transparently. If any of the controller ports fail, traffic is automatically migrated to one of the other ports

Preferred redundancy – Cisco Catalyst 9800 HA SSO pair connected to redundant single logical switch

LAG requires an EtherChannel Port Group to be configured on the attached Cisco Catalyst switch. The EtherChannel port group can be configured across multiple linecards on the switch, or across switches in a Ci

The following figure shows an example of wireless controller link aggregation in a high availability configuration to a Cisco StackWise Virtual pair. Similar connectivity is used when connecting to a distribution s

Figure 36. Preferred redundancy for controller HA SSO pair



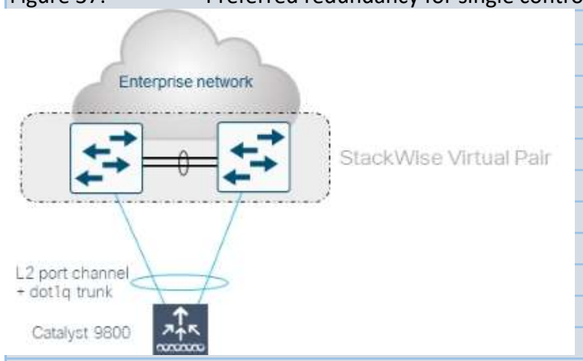

both switches within the Cisco StackWise Virtual pair is the recommended design. This design minimizes the traffic that crosses the virtual switch lin

**Note:** Catalyst 9800 wireless controllers support PagP and LACP as of IOS XE 17.1 and higher.

Preferred redundancy - Single Cisco Catalyst 9800 controller connected to redundant single logical switch

If you are only connecting a single Cisco Catalyst 9800 controller to the wired LAN, such as for an N+1 controller deployment, connect the single controller physical ports spread across redundant Cisco Catalyst sw

Figure 37. Preferred redundancy for single controller




The trunk configuration and switching platform choices from the previous design also apply here.

Wireless controller patches using software maintenance updates (SMUs)

An SMU is a software package that can be installed on a wireless controller to provide a patch fix for bugs or security resolution to an already released image. Cisco Catalyst 9800 Series controllers support two typ

A hot patch does not need a system reload - meaning that clients and APs will not be affected when applying the hot patch. When the wireless controller is part of an HA SSO pair, the SMU activation applies to bo

A cold patch does require a system reload. However, in an HA SSO pair, the system will first install the SMU on the standby controller and reload it. Once the standby finishes reloading the active controller will r

**Note:** SMUs are only released on long-lived Cisco IOS-XE extended maintenance releases.

AP patches using Access Point Service Packs (APSPs)

Cisco Catalyst 9800 Series wireless controllers support rolling out critical AP bug fixes using APSPs. APSP rollout can be based upon sites, with the fix predownloaded and rolled out to only affected AP models.

With rolling AP upgrade, AP upgrades can be staggered to ensure RF coverage to clients throughout the upgrade process. Rolling updates support automatic candidate selection using Radio Resource Management

Support for new AP models using Access Point Device Packs (APDPs)

Beginning with Cisco IOS-XE release 16.11, Cisco Catalyst 9800 Series wireless controllers provide a way to support new AP models using APDPs. This provides a way to introduce new AP models into your net

The following table summarizes high availability support with the various controllers.

**Table 4.** High availability feature support

| Platform | HA SSO | N+1 HA | Stack Redundancy | LAG | SMUs, APSPs, and APDPs |
|---|---|---|---|---|---|
| Cisco Catalyst 9800-80 | Yes | Yes | — | Yes | Yes |
| Cisco Catalyst 9800-40 | Yes | Yes | — | Yes | Yes |
| Cisco Catalyst 9800-L | Yes | Yes | — | Yes | Yes |
| Cisco Catalyst 9800 embedded on Cisco Catalyst 9000 Series Switches | No | No | Yes | — | Yes |
| Cisco Catalyst 9800 Embedded on Catalyst 9100 Series Access Points (EWC) | Active/standby control plane with local switching data plane | No | — | — | Yes |
| Cisco Catalyst 9800-CL for | No | Yes | — | — | Yes |
| Public Cloud | | | | | |
| Cisco Catalyst 9800-CL for Private Cloud | Yes | Yes | — | Via hypervisor | Yes |

Multicast support

Video and voice applications continue to grow as smartphones, tablets, and PCs are added to wireless networks in all aspects of our daily life. In each of the wireless design models, the multicast support to which u

The campus WLAN supports multicast transmission for the onsite controller using multicast-multicast mode, which uses a multicast IP address in order to more efficiently communicate multicast streams to APs th

Remote sites that use Cisco FlexConnect local switching mode can also benefit from the use of multicast-based applications. Multicast in remote sites leverages the underlying WAN and LAN support of multicast

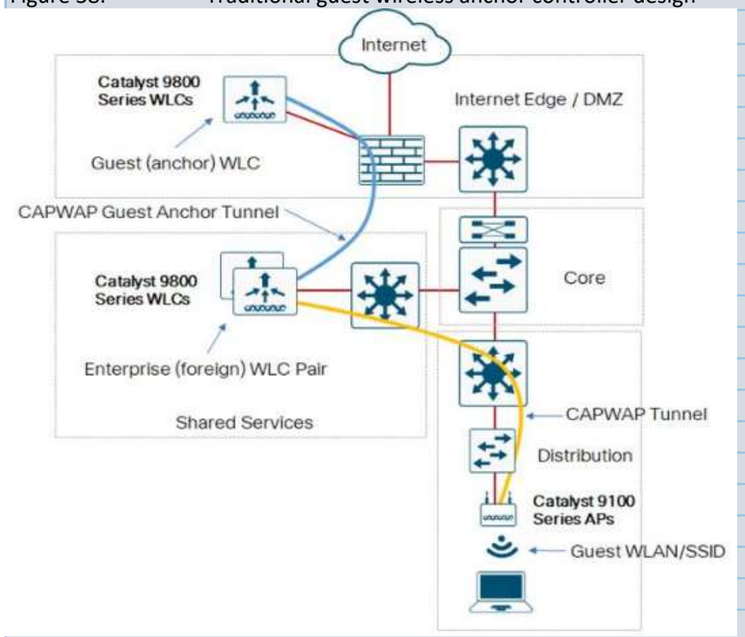
Guest wireless

Using the existing campus wired and wireless infrastructure for guest access provides a convenient, cost-effective way to offer Internet access for visitors and contractors. Multiple methods of providing guest wirel

Centralized deployments with guest wireless

For centralized (local-mode) deployments, the traditional method of providing wireless guest access is to implement a dedicated guest anchor controller in an Internet DMZ segment. The internet edge / DMZ firew

Figure 38. Traditional guest wireless anchor controller design



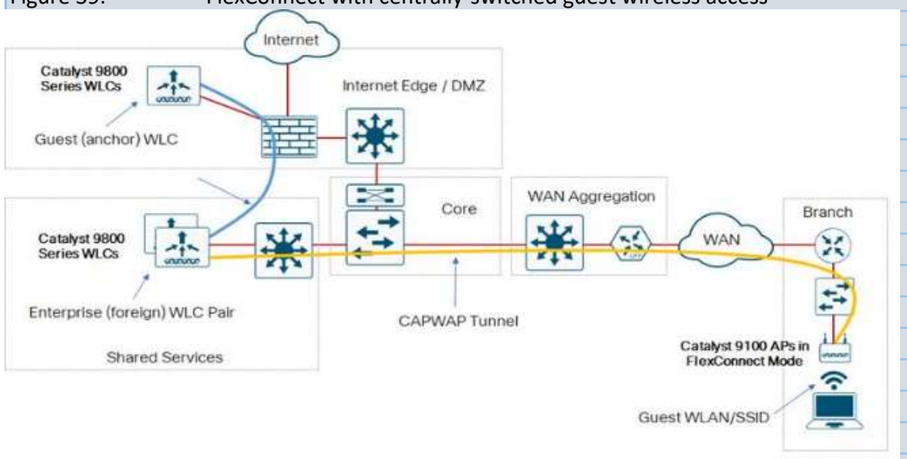

Additional security functionality besides firewalling may be applied within the Internet Edge / DMZ. This additional functionality is not shown in the figure above.

Cisco Catalyst 9800 Series wireless controllers support secure mobility – meaning the anchor tunnel uses CAPWAP encapsulation, as opposed to Ethernet-over-IP (EoIP). CAPWAP control traffic is encrypted, wi

Cisco FlexConnect guest deployments

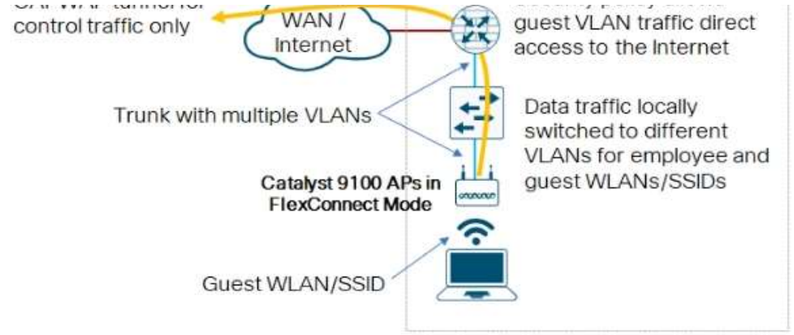
For Cisco FlexConnect guest deployments, the guest WLAN/SSID can be centrally switched and anchored through a dedicated guest controller in an Internet DMZ segment.

Figure 39. FlexConnect with centrally-switched guest wireless access




Alternatively, the guest WLAN/SSID can be locally switched to a VLAN within the branch which provides direct Internet access (DIA).

Figure 40. FlexConnect with locally-switched guest wireless access


control traffic only
WAN / Internet
guest VLAN traffic direct access to the Internet
Trunk with multiple VLANs
Data traffic locally switched to different VLANs for employee and guest WLANs/SSIDs
Catalyst 9100 APs in FlexConnect Mode
Guest WLAN/SSID

branch for direct Internet access. This is not shown in the figure above.

Cisco SD-Access deployments with guest wireless

For fabric wireless guest access services to the Internet, you can separate wireless guests from other network services by creating a dedicated virtual network (VN) supporting the guest SSID. Extend the separation

For more information, see the Software-Defined-Access Solution Design Guide, at https://cs.co/sda-sdg.

Cisco Catalyst 9100 Series EWC deployments guest wireless

Cisco Catalyst 9100 Series EWC deployments do not support a dedicated guest anchor wireless controller. As with FlexConnect locally switched deployments, the guest WLAN/SSID can be locally switched to a V

All guest wireless deployments—authentication and access control

Regardless of the wireless deployment option, the wireless guest network typically provides the following functionality:

- Provides Internet access to guests through an open wireless SSID, with web authentication access control.
- Supports the creation of temporary authentication credentials for each guest by an authorized internal user.
- Keeps traffic on the guest network separate from the internal network in order to prevent a guest from accessing internal network resources.

Most organizations' IT departments choose to have guest wireless users authenticate first, before allowing access to the Internet. This step is sometimes accompanied with the guest user reading and agreeing to an

There are multiple ways of authenticating guests on WLANs, such as the following:

- **Local web authentication**—With this method, the web session of the guest device is redirected by the guest wireless controller to a web portal containing the login screen within the guest wireless controller. T
- **Central web authentication**—With this method, the web session of the guest device is redirected by the guest wireless controller to an external web portal containing the login screen. The guest's credentials ar
- **Cisco DNA Spaces-based guest onboarding**—Cisco DNA Spaces-based guest-onboarding is often implemented by organizations who wish to provide free Internet access within their venue, in exchange for co

Multicast domain name services and Bonjour gateway

Bonjour is Apple's zero-configuration protocol for advertising, discovering, and connecting to network services such as file sharing, print sharing, and media sharing. The Bonjour protocol was originally designed

To address this limitation and to meet user demand for BYOD Apple devices within the enterprise, Cisco developed the Bonjour Gateway feature for its WLCs, in addition to Service Discovery Gateway (SDG) on

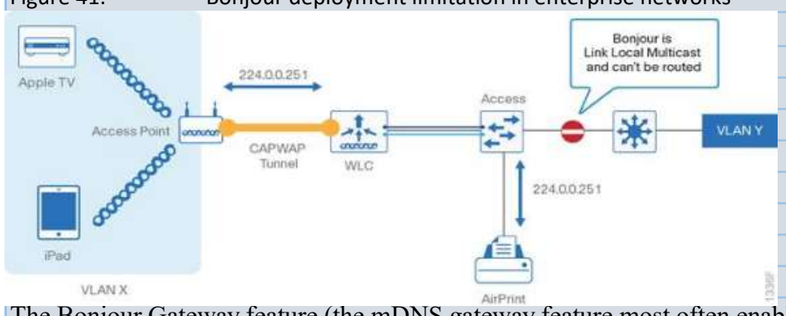
The Bonjour protocol uses mDNS queries. These queries are sent over UDP port 5353 to these reserved group addresses:

- IPv4 Group Address: `224.0.0.251`
- IPv6 Group Address: `FF02::FB`

It is significant to highlight that mDNS addresses used by Bonjour are link-local multicast addresses and are only forwarded within the local Layer 2 domain, because link-local multicast is meant to stay local by de

This link-local multicast limitation of Bonjour mDNS is illustrated in the following figure.

Figure 41. Bonjour deployment limitation in enterprise networks




The Bonjour Gateway feature (the mDNS gateway feature most often enabled for Bonjour) snoops and caches all Bonjour service advertisements across multiple VLANs and can be configured to selectively reply t

Bonjour gateway service policy deployment options

A key functional advantage of the Bonjour gateway is that it can be configured to selectively reply to Bonjour service requests, thus allowing for administrative control of Bonjour services within the enterprise. For

Since the Cisco Catalyst 9800 Series wireless controller will respond and advertise for services cached when acting as a Bonjour gateway, it must have an SVI interface with a valid IP address on every VLAN wher

Cisco Application Visibility and Control

The Cisco Application Visibility and Control (AVC) solution —already supported on Cisco routing platforms such as the Cisco ASR 1000 and Cisco ISR, and Cisco switching platforms such as the Cisco Catalyst

The Cisco AVC feature set increases the visibility, productivity, and manageability of the wired and wireless network. Additionally, the support of AVC embedded within the WLAN infrastructure extends Cisco's

AVC includes these components:

- Next-generation deep packet inspection (DPI) technology called Next Generation Network-Based Application Recognition (NBAR2), which allows for identification and classification of applications. Available
- Ability to remark applications using DSCP policies, which you can then use to prioritize or de-prioritize applications for QoS treatment over both the wired and wireless networks.
- A template for Cisco Flexible NetFlow v9 to select and export data (local-mode only) of interest to Cisco PI or a third-party NetFlow collector to collect, analyze, and save reports for troubleshooting, capacity pl

Cisco AVC on the Cisco Catalyst 9800 Series wireless LAN controllers inherits NBAR2 from Cisco IOS-XE that provides DPI technology in order to classify stateful L4-L7 application classification. This is critica

After the NBAR engine recognizes applications by their discrete protocol signatures, it registers this information in a Common Flow Table so that other WLC features, such as Flexible NetFlow and QoS, can lever

Cisco AVC provides:

- Application Visibility on the Cisco Catalyst 9800 Series WLC by enabling Application Visibility for any WLAN wireless policy profile configured. Once you enable Application Visibility, the NBAR engine cla
- Application Control on the Cisco Catalyst 9800 Series WLC by creating an AVC-based QoS policy and attaching it to a policy profile attached to a WLAN. The QoS policy supports rules per application matche

Key business use cases for Cisco AVC include:

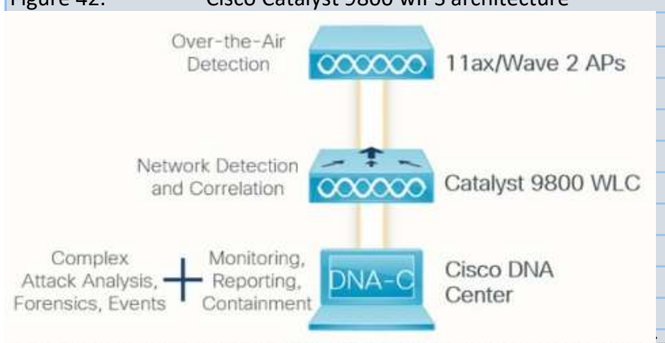
- **Classifying and marking wireless mobile device applications**—Identifying and differentiating real-time voice, video, or business-critical applications from less important (but potentially bandwidth-hungry) ap
- **Capacity planning and trending**—Baselining the network to gain a clearer understanding of what applications are consuming bandwidth and trending application use in order to help network administrators pla

Cisco Catalyst 9800 advanced wireless intrusion prevention system (wIPS)

The Cisco Catalyst 9800 advanced wIPS architecture—available in Cisco IOS-XE 17.1 and higher—provides the following benefits:

- Low footprint solution
- Ease of Cisco DNA licensing (requires Cisco DNA Advantage licensing)
- Alarm consolidation

Figure 42. Cisco Catalyst 9800 wIPS architecture




The basic system components for a Cisco Catalyst 9800 adaptive wIPS system include:

- Cisco 802.11ax or 802.11ac Wave 2 APs (local-mode, Cisco FlexConnect mode, or monitor mode)
- Cisco Catalyst 9800 Series Wireless controllers (local-mode, Cisco FlexConnect, or fabric deployments)
- Cisco DNA Center

**Table 5.** Alarms supported in Cisco IOS-XE 17.1

| Alarm ID | Alarm |
|---|---|
| 10001 | DoS: Authentication Flood Alarm |

| | | |
|---|---|---|
| 10002 | DoS: Association Request Alarm | |
| 10003 | DoS: Broadcast Probe Flood Alarm | |
| 10004 | DoS: Dissociation Flood Alarm | |
| 10005 | DoS: Broadcast Dis-Association Alarm | |
| 10006 | DoS: De-Authentication Flood Alarm | |
| 10007 | DOS: Broadcast De-authentication Alarm | |
| 10008 | DOS: EAPOL-Logoff Attack Alarm | |

Rogue device detection

An organization can regard any device unmanaged by the organization that shares the organization’s RF spectrum as a rogue device. A rogue device becomes dangerous in the following scenarios:

- Rogue AP with the same SSID as your network (often called a *honeypot* )
- Rogue AP device also on the wired network
- Ad-hoc rogue devices
- Rogue devices set up for malicious intent by someone outside the organization

There are three main phases of rogue device management in the Cisco Catalyst wireless solution:

- **Detection**—Managed using RRM scanning in order to detect the presence of rogue devices.

- **Classification**—Managed using rogue location discovery protocol (RLDP) and switch port tracing in order to identify whether the rogue device is connected to the wired network. Rogue device classification rul
- **Mitigation**—Managed using switch port tracing and disablement, rogue device location, and rogue device containment in order to track down physical location and nullify the threat of rogue devices.

Cisco DNA Center release 1.3.1.3 and higher supports the Rogue Management application within Cisco DNA Assurance. The Rogue Management application allows you visualize rogue APs as well as their poten

For additional information about a range WLAN controller versions, visit cisco.com and search for "Wireless Rogue Management."

Radio Resource Management (RRM)

To optimize efficiency, RRM software embedded in the Cisco Wireless LAN Controller acts as a manager to constantly monitor over-the-air metrics and control the RF transmitted. It measures:

- **Signal**—Your own APs belonging to the same RF network.
- **Interference**—Other 802.11 devices operating nearby that can be heard by your network.
- **Noise**—Any energy in the RF spectrum that cannot be demodulated as 802.11 protocol.
- **Load**—Instantaneous user load on the network.
- **Coverage**—The RSSI and signal-to-noise ratio estimated by the system for clients attached to your network.

Using this information, RRM can periodically reconfigure the 802.11 RF network for best efficiency. To do this, RRM performs these functions:

- **RRM data collection**—Collecting the metrics
- **Transmit Power Control (TPC) algorithm**—Adjusting for optimal power levels
- **Dynamic channel assignment (DCA)**—Ensuring that channel assignments do not overlap
- **Cisco Flexible Radio Assignment (FRA)**—Determines the role of the flexible radio for APs with that flexible radio capability
- **Coverage Hole Detection and Mitigation (CHDM) algorithm**—Ensuring that you have adequate coverage and detecting clients that may be in a coverage hole

RRM automatically detects and configures new Cisco WLCs and Cisco Catalyst APs as they are added to the network. It then automatically adjusts associated and nearby APs to optimize coverage and capacity.

For more detailed information about what RRM does and how it takes its measurements, see the Radio Resource Management White Paper on cisco.com.

Transmit power control

The Cisco WLC dynamically controls AP transmit power based on real-time WLAN conditions. Cisco Catalyst 9800 Series WLCs support TPCv1 only. With TPCv1, typically power can be kept low to gain extra c

Overriding the TPC algorithm with minimum and maximum transmit power settings

The TPC algorithm balances RF power in many diverse RF environments. However, it is possible that automatic power control will not be able to resolve some scenarios in which an adequate RF design was not pc

In these scenarios, you can configure maximum and minimum transmit power limits to override TPC recommendations. The maximum and minimum TPC power settings apply to groups of APs through the use of

If you configure a minimum transmit power, RRM does not allow any AP attached to the controller to go below this transmit power level, regardless of which function is directing the power change (RRM TPC or c

Dynamic Channel Assignment

The 802.11 specification defines multiple channels for operation. The channels are essentially different frequency ranges that are non-overlapping and can be assigned using a channel designator. The behavior is an

Channels in an RF network work similarly. However, there is an additional consideration of power, equivalent to making lane wider or narrower (the coverage of the AP). The job of Dynamic Channel Assignment

After all APs have been installed, it is a best practice to then calibrate DCA by invoking the RRM start-up mode. The RRM startup mode is invoked in the following conditions:

- In a single-controller environment, the RRM startup mode is invoked after a successful upgrade of the controller software; otherwise, it is manually initiated (see below).
- In a multiple-controller environment, the RRM startup mode is invoked after an RF Group leader has successfully upgraded the software; otherwise, it is manually invoked from the CLI.

You can trigger RRM startup mode from CLI, using the following command:

```
ap dot11 {24ghz | 5ghz} rrm dca restart
```

RRM startup mode runs for 100 minutes (10 iterations at 10-minute intervals). The startup mode consists of 10 DCA runs with high sensitivity and no dampening (making channel changes easy and sensitive to the

Cisco Flexible Radio Assignment

Cisco FRA is a feature that takes advantage of hardware choices available in the Cisco Catalyst 9100 Series APs. As described for band selection, there are limitations using the 2.4 GHz spectrum. If you are deploy

Cisco FRA first identifies redundant APs and then manages the changing of the single XOR radio to another band. Cisco FRA relies on hardware capabilities as well as existing DCA in order to manage the switch

Coverage Hole Detection and Mitigation algorithm

The RRM CHDM algorithm detects areas of weak radio coverage in a WLAN that are below the level needed for robust radio performance. This feature can alert you to the need for an additional or relocated AP.

If clients associated to an AP are detected at threshold levels lower than those specified in the RRM configuration, the AP sends a “coverage hole” alert to the controller. The thresholds include RSSI, failed client c

Benefits of RRM

RRM produces a network with optimal capacity, performance, and reliability. It frees you from having to continually monitor the network for noise and interference problems, which can be transient and difficult to

Band Select

Most consumer devices being released today operate in one or both of two frequency ranges, or, *bands* . Dual-band devices are quite common; however, the bands supported by the devices are not created equally.

Band Select allows identification of dual-band clients and helps the devices make informed decisions about which frequency range and AP to select. The system does this by simply delaying the response to the 2.4

Organizations are advised to enable Band Select in all environments. For more information on configuring Band Select, visit cisco.com and search for Wireless Controller Configuration 802.11 Bands.

Dynamic bandwidth selection (DBS)

With the introduction of 802.11n, 802.11ac Wave 1 and Wave 2, and 802.11ax, you can use multiple channels together as a single assignment on a given AP. This increases the amount of bandwidth available for a

Bonding channels—using multiple single channels to create a single super channel—has the advantage of providing more usable throughput to a client with the capability to use the channel. However, in grouping r

Dynamic Bandwidth Selection works with the DCA algorithm to monitor the APs and the client types and capabilities using the APs. Based on this analysis, DBS assigns appropriate channel widths to APs to dyna

DBS allows appropriately sized bandwidth to be used for the clients being served, avoids wasting multiple channels for devices that likely could not use the added capacity, and avoids the associated interference cr

For additional details, visit cisco.com and search for High Density Experience (HDX) Deployment Guide.

Cisco CleanAir

Cisco CleanAir is a purpose-built spectrum intelligence solution designed to proactively manage the non-Wi-Fi interference in the 2.4 and 5 GHz spectrums. Many consumer devices use the same frequencies that a

Cisco CleanAir is an innovation available in Cisco Catalyst 9120AX and 9130AX APs, which include the Cisco RF ASIC. CleanAir is dedicated to detecting and identifying sources of interference that otherwise w

Cisco CleanAir technology was released in 2010 and has continuously adapted to keep pace with the market and changing nature of the WLAN spectrum. CleanAir monitors the full channel bandwidth capability c

CleanAir can report analysis and findings through the WLAN controller. You can use certain Cisco DNA Spaces implementations and Cisco Prime to map both the interference and the impact of the interference fo

At the controller level, you can use two mitigation strategies to help maintain your network and prevent outages associated with common non-Wi-Fi interference sources:

- **Persistent Interference Avoidance**—Allows the WLC to track and report non-Wi-Fi interferers to DCA. For instance, there may be a microwave oven that becomes quite active around lunchtime every day. P
- **ED-RRM**—Helps mitigate disruptions from interference sources (perhaps a video camera) that use 100% of the available airtime when enabled. Because this interference is not recognizable as anything other tha
  - Recognizing that something is not noise but instead is intentionally transmitting and interfering with the network operations.
  - Forcing the AP away from the problematic channel to a channel where operations can resume. The resolution is very fast acting (30 seconds or less), and the information about the interference is incorporated int

As a best practice, you should enable CleanAir, Persistent Device Avoidance, and ED-RRM.

For additional details, visit cisco.com and search for the Cisco CleanAir Technology: Intelligence in Action White Papers.

Secure WLANs

Wireless devices should connect to the network infrastructure securely where possible. In an enterprise environment, secure the WLANs by configuring at least WPA2 with AES-CCMP encryption, and 802.1x auth

WPA3 is the latest version of Wi-Fi Protected Access (WPA), which is a suite of protocols and technologies that provide authentication and encryption for Wi-Fi networks. WPA3 leverages Simultaneous Authent

WPA3-Personal protects individual users better by using more robust password-based authentication making the brute-force dictionary attack much more difficult and time-consuming. WPA3-Enterprise provides h

Opportunistic Wireless Encryption (OWE) is an extension to IEEE 802.11 that provides encryption of the wireless medium. The purpose of OWE based authentication is avoid open unsecured wireless connectivity

The use of older security methods, such as WEP or WPA, is not recommended due to known security vulnerabilities. 802.1x authentication requires an AAA server—such as Cisco ISE—that provides centralized p

Typically, the AAA server will implement the RADIUS protocol between itself and the WLC. Authentication of end-users is accomplished via an extensible authentication protocol (EAP) session between the wire

It is highly recommended that you deploy redundant AAA servers for high availability in case one or more servers become temporarily unavailable. Often the AAA server is configured to reference an external dire

The use of WPA2 with AES-CCMP encryption on the WLAN does not extend to management frames. Therefore, the optional use of protected management frames (PMF) is advisable for WLANs where possible.

In a home-office environment, it may be necessary to configure a WLAN to support WPA2 with pre-shared key (PSK). This is sometimes referred to as WPA Personal on wireless devices. This may be necessary

The use of a dedicated, open WLAN is still common, but not ideal, for wireless guest access. Therefore, the configuration of an unsecure WLAN on the network infrastructure may still be necessary. Open access

Administrative Access Control

It is recommended that you implement secure administrative access control to wireless infrastructure components in order to mitigate against unauthorized access. You can typically implement administrative acces

For a small number of network infrastructure devices, configuring individual local administrator accounts on each infrastructure device may be acceptable. It is recommended that the number of administrators be l

As the number of infrastructure devices within the network grows, the administrative burden of configuring individual local administrator accounts on each infrastructure device can become unmanageable. It is th

The AAA server may itself reference an external directory or data store such as AD. This allows the network administrator to leverage existing AD credentials instead of duplicating them within the AAA server. T

Where possible, the selection of a strong password—consisting of a minimum length, and combination of letters, numbers, and/or special characters—should be enforced. Where possible, a maximum number of u

It may be advantageous to limit where access to the wireless infrastructure device is initiated from and what protocols are allowed. You can accomplish this in multiple ways. For example, you can deploy the man

Access to wireless infrastructure devices should be via secure protocols such as HTTPS and SSHv2 where possible. Access via non-encrypted protocols such as HTTP and Telnet should be disabled where possible

Controller dashboard best practices checklist

For convenience of network deployment engineers, a best practices checklist is available within the dashboard for WLAN controllers. On Cisco Catalyst 9800 Series wireless controllers, the checklist separates best

Deployment Platform Choices: Campus Wired and Wireless LAN

An organization chooses from the spectrum of switching and wireless platforms based on the needs of capacity, capabilities, and compliance. For easy reference, the platform choices shown are grouped by overall

Small-site campus design

The small-site campus design is a single 24 or 48-port access switch or single access switch stack. The demands in the access layer for wired ports and WLAN devices typically number in the dozens (versus the hu

Campus wired access and wireless access

In the small-site campus design, you make choices for the wired access with a bias towards size and flexibility in order to accommodate the space and power requirements of small sites. Densities and advanced soft

**Table 6.** Small campus suggested deployment platforms (single-tier network)

| | Enterprise Class—base foundation network capabilities | Advanced—foundation plus additional network capabilities | Mission Critical—Best in class network capabilities |
|---|---|---|---|
| **Access switches** | Cisco Catalyst 9200 and 9200-L Series | Cisco Catalyst 9300 and 9300-L Series | Cisco Catalyst 9404R Switch |
| **WLAN controller** | Cisco Catalyst 9800 Embedded on Catalyst 9100 Series Access Points (EWC) or Cisco Catalyst 9800-CL | Cisco Catalyst 9800-L HA SSO pair or N+1 or Cisco Catalyst 9800-CL | Cisco Catalyst 9800-L HA SSO pair |
| **APs** | Cisco Catalyst 9115AX or 9117AX Series | Cisco Catalyst 9120AX Series | Cisco Catalyst 9130AX Series |

| | | | | |
|---|---|---|---|---|
| **Key capabilities—wired** | Gigabit Ethernet access | Gigabit Ethernet services, MACsec, TrustSec NetFlow, PoE+ | Gigabit Ethernet services, MACsec, TrustSec NetFlow, UPOE | |
| **Key capabilities—wireless** | Wi-Fi 6 (802.11ax), OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Apple Features | Wi-Fi 6 (802.11ax), Cisco RF ASIC, Uplink/Downlink OFDMA, MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | Wi-Fi 6 (802.11ax) certified, Cisco RF ASIC, Uplink/Downlink OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | |

| | | | | |
|---|---|---|---|---|
| | mGig, Cisco CleanAir, Three radios: 2.4 GHz (4x4), 5 GHz (4x4)or(8x8), and BLE | mGig, Cisco CleanAir, HDX, FRA, Four radios: 2.4 GHz (4x4), 5 GHz (4x4), Cisco RF ASIC, and BLE/IoT hardware capable | mGig, Cisco CleanAir, HDX, FRA, Four radios: 2.4 GHz (4x4), 5 GHz (8x8 and 4x4), Cisco RF ASIC, and BLE/IoT hardware capable | |

Medium-density campus design

The medium-density campus design adds a single distribution layer to the access layer, which can be standalone or used as a collapsed core connected to another distribution, or other services, or perhaps connected

Campus wired distribution, wired access, and wireless

You make choices for the wired distribution and access with a bias towards size and flexibility in order to accommodate the space and power requirements of medium sized installations in a way that can elastically

The medium-density designs are equivalent to the small-site campus design with the addition of a distribution layer.

**Table 7.** Medium campus suggested deployment platforms (two-tier network)

| | Enterprise Class—base foundation network capabilities | Advanced—foundation plus additional network capabilities | Mission Critical—Best in class network capabilities | |
|---|---|---|---|---|
| **Distribution/aggregation switches** | Cisco Catalyst 9400 Series | Cisco Catalyst 9500 Series | Cisco Catalyst 9600 Series | |
| **Access switches** | Cisco Catalyst 9200 and 9200-L Series | Cisco Catalyst 9300 and 9300-L Series | Cisco Catalyst 9400 Series | |
| **WLAN controller** | Cisco Catalyst 9800-40 or Cisco Catalyst 9800-CL | Cisco Catalyst 9800-40 HA SSO pair or N+1 | Cisco Catalyst 9800-40 HA SSO pair | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **APs** | Cisco Catalyst 9115AX or 9117AX Series | Cisco Catalyst 9120AX Series | Cisco Catalyst 9130AX Series | | |
| | **Key capabilities—wired** | 1/10 Gigabit Ethernet services, MACsec, TrustSec NetFlow | 1/10 Gigabit Ethernet services, MACsec, TrustSec NetFlow, UPOE | 1/10/40 Gigabit Ethernet services, MACsec, TrustSec, NetFlow, UPOE | | |
| | **Key capabilities—wireless** | Wi-Fi 6 (802.11ax), OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Apple Features | Wi-Fi 6 (802.11ax), Cisco RF ASIC, Uplink/Downlink OFDMA, MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | Wi-Fi 6 (802.11ax) certified, Cisco RF ASIC, Uplink/Downlink OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | | |

| | | | | | |
|---|---|---|---|---|---|
| | mGig, Cisco CleanAir, Three radios: 2.4 GHz (4x4), 5 GHz (4x4)or(8x8), and BLE | mGig, Cisco CleanAir, HDX, FRA, Four radios: 2.4 GHz (4x4), 5 GHz (4x4), Cisco RF ASIC, and BLE/IoT hardware capable | mGig, Cisco CleanAir, HDX, FRA, Four radios: 2.4 GHz (4x4), 5 GHz (8x8 and 4x4), Cisco RF ASIC, and BLE/IoT hardware capable | | |

High-density large campus design

The high-density large campus design has multiple distribution layers connected to a core layer and dense demands in the access layer for wired ports and WLAN devices. You may select this design for cases where

Campus core

If there are three or more interconnected distributions or requirements for connectivity at a common location, you use a Layer 3 LAN core in order to simplify the connectivity and management. You use one of the

- Cisco Catalyst 9600 Series—The lead high-density modular platform choice.
- Cisco Catalyst 9500 Series—The lead lower-density fixed platform choice.

Campus wired distribution, wired access, and wireless

In the high-density large campus, you make choices for the wired distribution and access based on the most highly available platforms for the role, the highest density and widest selection of interface options, redu

In the high density large campus design, centralized wireless is the preferred option, using APs with 802.11ac Wave 2 and CleanAir capabilities.

**Table 8.** High-density large campus suggested deployment platforms (three-tier network)

| | Enterprise Class—base foundation network capabilities | Advanced—foundation plus additional network capabilities | Mission Critical—Best in class network capabilities | |
|---|---|---|---|---|
| **Core switches** | Cisco Catalyst 9500 Series | Cisco Catalyst 9600 Series | Cisco Catalyst 9600 Series | |
| **Distribution/aggregation switches** | Cisco Catalyst 9400 Series | Cisco Catalyst 9500 Series | Cisco Catalyst 9600 Series | |
| **Access switches** | Cisco Catalyst 9200 and 9200-L Series | Cisco Catalyst 9300 and 9300-L Series | Cisco Catalyst 9400 Series | |
| **WLAN controller** | Cisco Catalyst 9800-80 | Cisco Catalyst 9800-80 HA SSO pair | Cisco Catalyst 9800-80 HA SSO pair | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | **APs** | Cisco Catalyst 9115AX or 9117AX Series | Cisco Catalyst 9120AX Series | Cisco Catalyst 9130AX Series | | |
| | **Key capabilities—wired** | 1 Gigabit Ethernet access, PoE+ | 1/10/40 Gigabit Ethernet services, MACsec, TrustSec MPLS, NetFlow, UPOE | Highest availability 1/10/40/100 Gigabit Ethernet services, MACsec, TrustSec MPLS, NetFlow, UPOE | | |
| | **Key capabilities—wireless** | Wi-Fi 6 (802.11ax), OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Apple Features | Wi-Fi 6 (802.11ax), Cisco RF ASIC, Uplink/Downlink OFDMA, MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | Wi-Fi 6 (802.11ax) certified, Cisco RF ASIC, Uplink/Downlink OFDMA, Uplink/Downlink MU-MIMO, BSS Coloring, Target Wake Time (TWT), Intelligent Capture, Container support for applications, Apple Features | | |

| | | | | | |
|---|---|---|---|---|---|
| | mGig, Cisco CleanAir, Three radios: 2.4 GHz (4x4), 5 GHz (4x4)or(8x8), and BLE | mGig, Cisco CleanAir, HDX, FRA, Four radios: 2.4 GHz (4x4), 5 GHz (4x4), Cisco RF ASIC, and BLE/IoT hardware capable | mGig, Cisco CleanAir, HDX, FRA, Four radios: 2.4 GHz (4x4), 5 GHz (8x8 and 4x4), Cisco RF ASIC, and BLE/IoT hardware capable | | |

Operate: Common Components in Campus Designs

Device management using Cisco ISE

Without a centralized access and identity policy enforcement point, it's difficult to ensure the reliability of a network as the number of network devices and administrators increases.

Cisco ISE operates as a centralized AAA server that combines user authentication, user and administrator access control, and policy control in a single solution. Cisco ISE uses a rule-based policy model, which allo

The capabilities of Cisco ISE coupled with a AAA configuration on the network devices reduce the administrative issues that surround having static local account information on each device. Cisco ISE can provide

Rule-based mapping of users to identity groups can be based on information available in an external directory or an identity store such as Microsoft Active Directory. Network devices can be categorized in multiple

These same authorization rules allow for privilege-level authorization, which can be used to give limited access to the commands on a device. For example, a rule can give network administrators full access to all c

Cisco DNA Center

As networks and the number of services they support continue to evolve, the responsibilities of network administrators to maintain and improve their efficiency and productivity also grow. Using a network manage

Cisco DNA Center is a controller for planning, preparation, installation, and integration. Cisco SD-Access is one of the many software application packages that run on DNA Center.

Cisco DNA Center centrally manages major workflow areas, including:

- **Design**—Configures device global settings, network site profiles for physical device inventory, DNS, DHCP, IP addressing, software image management, plug-and-play, and user access.
- **Policy**—Defines business intent for provisioning into the network, including creation of virtual networks, assignment of endpoints to virtual networks, and policy contract definition for groups.
- **Provision**—Provisions devices for management and creates fabric domains, control plane nodes, border nodes, edge nodes, fabric wireless, local-mode wireless, and external connectivity.
- **Assurance**—Enables health scores dashboard, client/device 360° views, node, client, and path traces.

Cisco DNA Center supports integration using APIs.  For example, Infoblox IP address management and policy enforcement integration with ISE are available through DNA Center.  A comprehensive set of northbo

- All controller functionality is exposed through northbound REST APIs.
- Organizations and ecosystem partners can easily build new applications.
- All northbound REST API requests are governed by the controller RBAC mechanism.

Cisco DNA Center is key to enabling automation of device deployments into the network providing the speed and consistency required for operational efficiency. Organizations using Cisco DNA Center can benefi

Cisco Prime Infrastructure

Cisco Prime Infrastructure is a sophisticated network management tool that can help support the end-to-end management of network technologies and services that are critical to the operation of your organization; i

With a campus network and the services that it can support, Cisco Prime Infrastructure can play a critical role in day-to-day network operations.

Device Work Center

Cisco Prime Infrastructure includes the Device Work Center. Some of the features found in the Device Work Center are:

- **Discovery**—Builds and maintains an up-to-date inventory of managed devices, including software image information and device configuration details.
- **Configuration Archives**—Maintains an active archive of multiple iterations of configuration files for every managed device.
- **Software Image Management**—Enables a network administrator to import software images from Cisco.com, managed devices, URLs, or file systems, and then distribute them to a single device or group of dev

Configuration Templates and Tasks

Using the Configuration Tasks feature to apply configuration templates to many devices, administrators can save many hours of work. Cisco Prime Infrastructure provides a set of templates and you can use them to

Alarms, Events, and Syslog Messages

Cisco Prime Infrastructure provides the Alarms and Events feature, which is a unified display with detailed forensics. The feature provides actionable information and the ability to automatically open service reque

Reporting

Cisco Prime Infrastructure provides you a single launch point for all reports that you can configure, schedule, and view. The Report Launch Pad page provides access to over 100 reports, each of which you can cust

Cisco CleanAir support

Cisco Prime Infrastructure supports the management of CleanAir enabled wireless APs, enabling administrators to see interference events.

Network Analysis Module support

For increased visibility into your network, Cisco Prime Infrastructure supports management and reporting for Cisco Network Analysis Module products.

Cisco Prime Infrastructure and Cisco DNA Center choices for WLAN deployments

The following are recommendations when deciding to use Cisco Prime Infrastructure instead of, or in addition to, deploying Cisco DNA Center to manage an organization's wireless deployment.

Organizations with new WLAN deployments

If you are an organization with a new wireless deployment, consider using Cisco DNA Center for both automation (management) and assurance. The Plug-and-Play (PnP) feature of Cisco DNA Center can be used

Organizations refreshing wireless networks or deploying new wireless sites

If you are an organization refreshing your WLAN with Cisco Catalyst 9800 Series WLCs and Cisco Catalyst 9100 Series APs to take advantage of new HA capabilities (such as wireless controller Software Mainte

- For new sites, consider using Cisco DNA Center for both automation (management) and assurance.
- For existing sites, consider Prime – Cisco DNA Center co-existence for network management. Use Cisco Prime Infrastructure for reporting, compliance, configuration, and for legacy device support. Use Cisco

**Note:** Cisco Prime Infrastructure release 3.5.1 update 1 and higher includes a Prime to Cisco DNA Center co-existence tool. The tool is designed to jumpstart your Cisco DNA Center deployment with a readily a

Organizations with existing WLAN deployments

For organizations with existing WLAN in production deployments, consider Cisco Prime Infrastructure coexistence with Cisco DNA Center for network management. Continue to use Cisco Prime Infrastructure fo

Campus quality of service (QoS)

Because real-time communication traffic is very sensitive to delay and drop, the network must ensure that this type of traffic is handled with priority so that the stream of audio or video is not interrupted. QoS is the

The primary role of QoS in rich-media campus networks is to manage packet loss, where high-bandwidth links with instantaneous congestion on the order of milliseconds can cause buffer overruns and a poor user

QoS allows an organization to define different traffic types and to create more deterministic handling for real-time traffic. QoS is especially useful in congestion handling, where a full communications channel mig

Within the campus wired LAN, Cisco keeps the QoS profiles as simple as possible while ensuring support for applications that need special delivery. This approach establishes a solid, scalable, and modular framev

The primary goals of implementing QoS within the network are:

- Expedited delivery service of communications for supported, real-time applications.
- Business continuance for business-critical applications.
- Fairness among all other applications when congestion occurs.
- Deprioritized background applications and non-business entertainment-oriented applications so that these do not delay interactive or business-critical applications.
- A trusted edge around the network to guarantee that users cannot inject their own arbitrary priority values and to allow the organization to trust marked traffic throughout the network.

To accomplish these goals, the design implements QoS across the network as follows:

- Establish a limited number of traffic classes (that is, four to twelve classes) within the network that need special handling (for example, real-time voice, real-time video, high-priority data, interactive traffic, batch
- Classify applications into the traffic classes.
- Apply special handling to the traffic classes to achieve intended network behavior.

To deploy QoS, use the Application Policy feature in Cisco DNA Center to configure quality of service on the discovered switching devices in your network. Application Policy allows you device-grouping and clas

For additional information, visit cisco.com and search for Application Policy.

Appendix: Glossary

**AAA** authentication, authorization, and accounting

**ACL** access control list

**ACS** Cisco Access Control Server

**AP** access point

**AQ** air quality

**AUP** acceptable use policy

| |
|---|
| **AVC** Cisco application visibility and control |
| **BGP** border gateway protocol |
| **BYOD** bring your own device |
| **CAPWAP** control and provisioning of wireless access points protocol |
| **DCA** dynamic channel assignment |
| **DFS** dynamic frequency selection |
| **DMZ** demilitarized zone |
| **DNA** Cisco Digital Network Architecture |
| **DPI** deep packet inspection |
| **EAP** extensible authentication protocol |
| **EUA** end-user agreement |
| **EVPN** Ethernet virtual private network |
| **FHRP** first-hop redundancy protocol |
| **FRA** flexible radio assignment |
| **G2** second generation |
| **GLBP** gateway load-balancing protocol |
| **HA** high availability |
| **HA SSO** high availability stateful switchover |
| **HSRP** hot standby routing protocol |
| **ISE** Cisco Identity Services Engine |
| **ISM** industrial, scientific, and medical band |
| **LACP** link aggregation control protocol |
| **LAG** link aggregation |
| **LAN** local area network |
| **mDNS** multicast domain name services |
| **MFP** management frame protection |
| **MIMO** multiple input, multiple output design |
| **NBAR2** Next Generation Network-Based Application Recognition |
| **PAgP** port aggregation protocol |
| **PHY** physical layer |
| **PI** Cisco Prime Infrastructure |
| **PMF** protected management frames |
| **PSK** pre-shared key |
| **QAM** quadrature amplitude modulation |
| **QoS** quality of service |
| **RBAC** role-based access control |
| **RF** radio frequency |
| **RRM** radio resource management |
| **RSSI** received signal strength indicator |
| **Cisco SD-Access** Cisco Software-Defined Access |
| **SSID** service set identifier |
| **SSO** stateful switchover |
| **STP** spanning tree protocol |
| **SVL** Cisco StackWise Virtual Link |
| **TPC** transmit power control |
| **TTL** time-to-live |

| |
|---|
| **TxBF** standards-based transmit beamforming |
| **UPOE** Cisco Universal Power Over Ethernet |
| **UPOE+** Cisco Universal Power Over Ethernet Plus |
| **VLAN** virtual local area network |
| **VRRP** virtual router redundancy protocol |
| **SV** StackWise Virtual |
| **vWLC** virtual wireless local area network controller |
| **VXLAN** virtual extensible local area network |
| **WAAS** wide area application services |
| **WAN** wide area network |
| **WIDS** wireless intrusion detection system |
| **wIPS** wireless intrusion prevention system |
| **WLAN** wireless local area network |
| **WLC** wireless local area network controller |
| **WSM** Wireless Security Module |
| |
| |
| |
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e, understanding the Salesforce architecture makes working with the platform a whole lot easier.

diagram

Applies To

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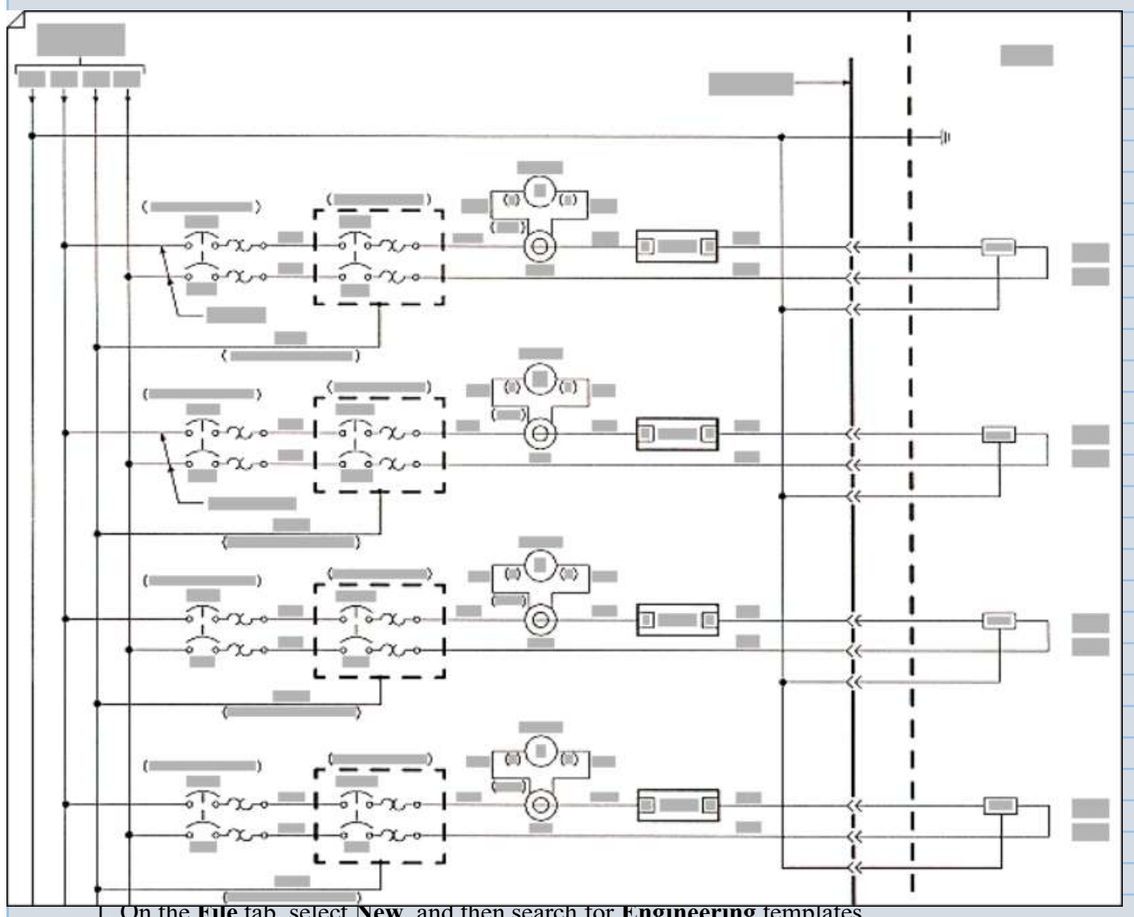

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2. Select one of the following:
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    - **Circuits and Logic**
    - **Fluid Power**
    - **Industrial Control Systems**
    - **Parts and Assembly Drawing**
    - **Piping and Instrumentation Design**

- **Plumbing and Piping Plan**
- **Process Flow Diagram**
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- **TQM diagram**
- **Work Flow Diagram**

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## Block diagram of a smart energy metering circuit architecture

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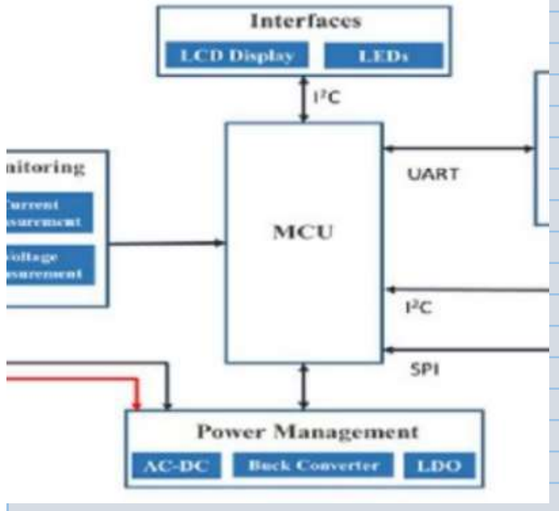

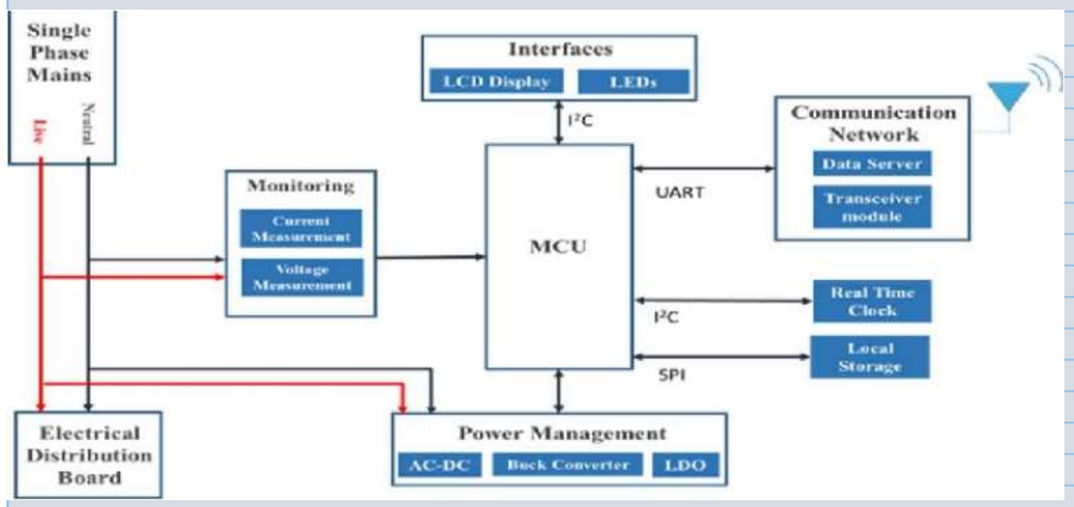


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**ARCHITECTURE AND APPLICATION DESIGN**

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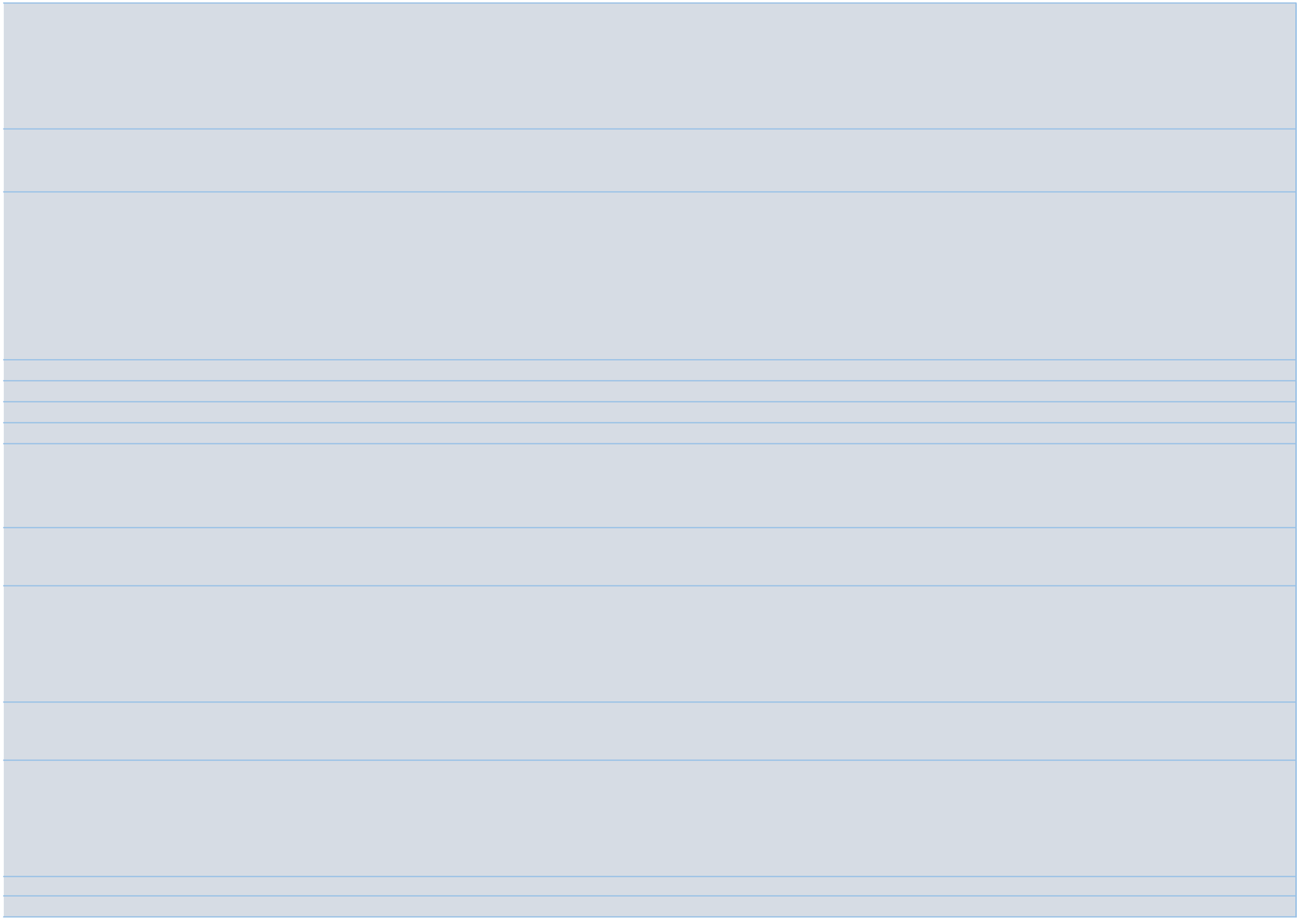

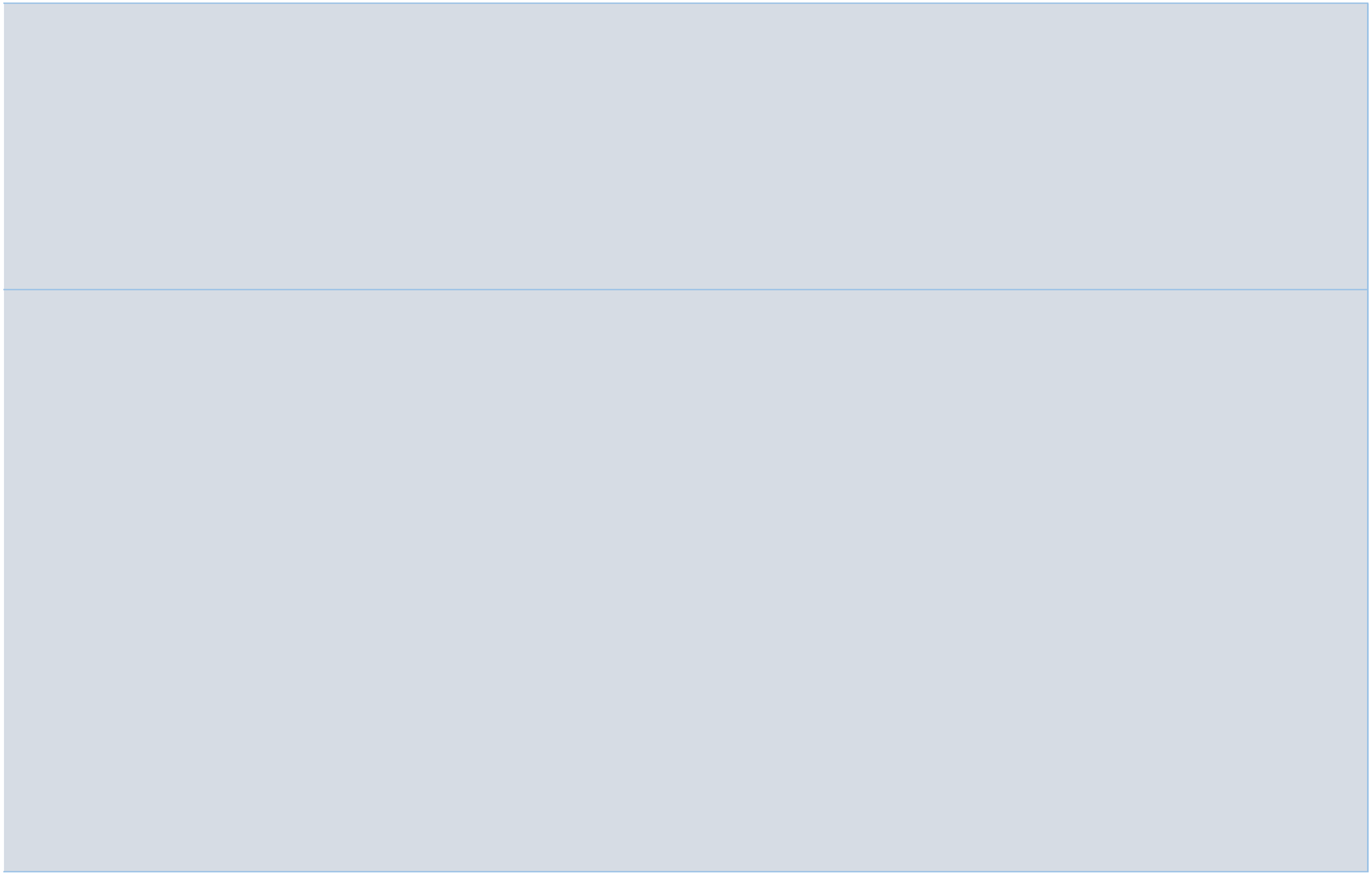

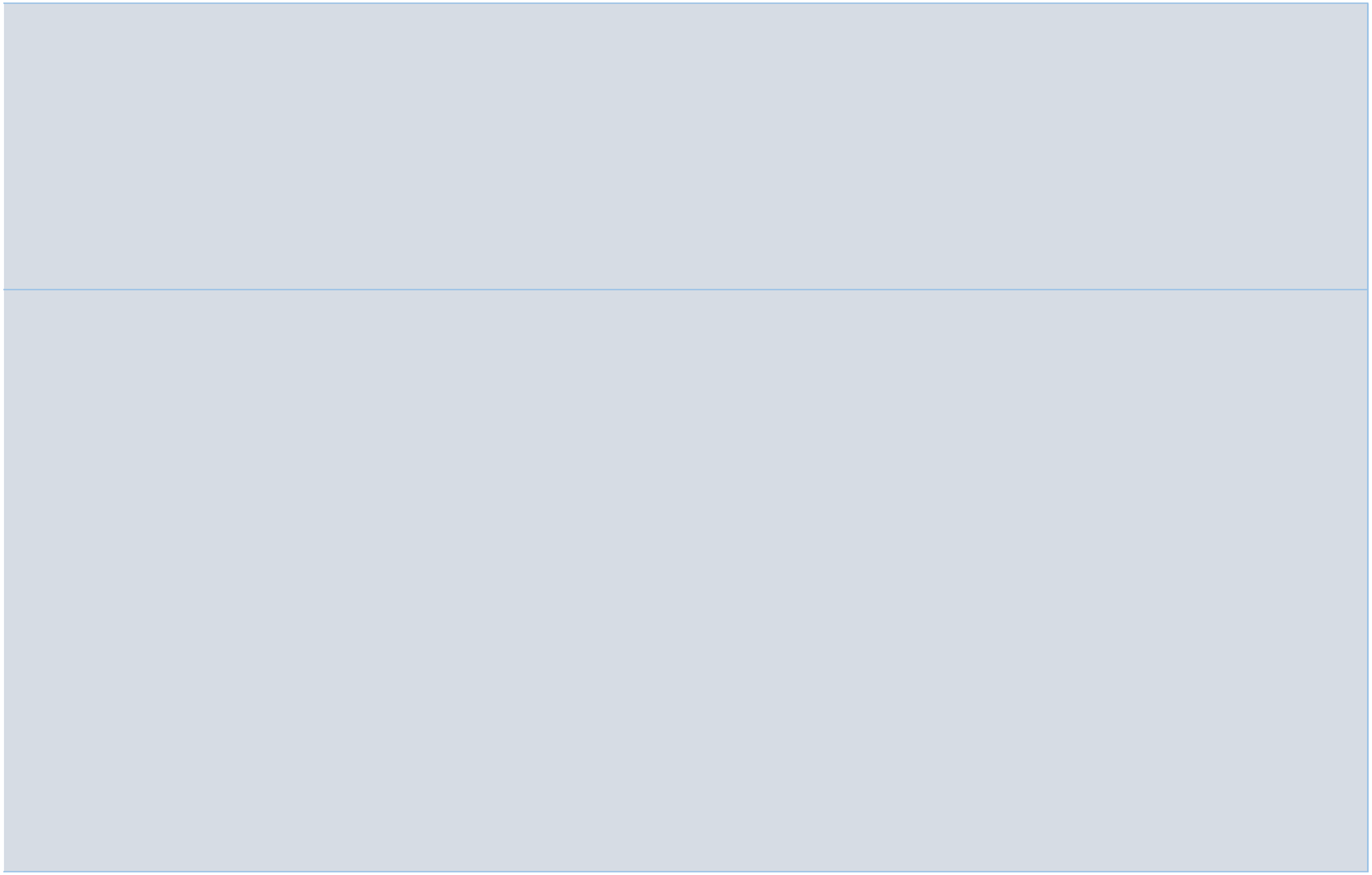

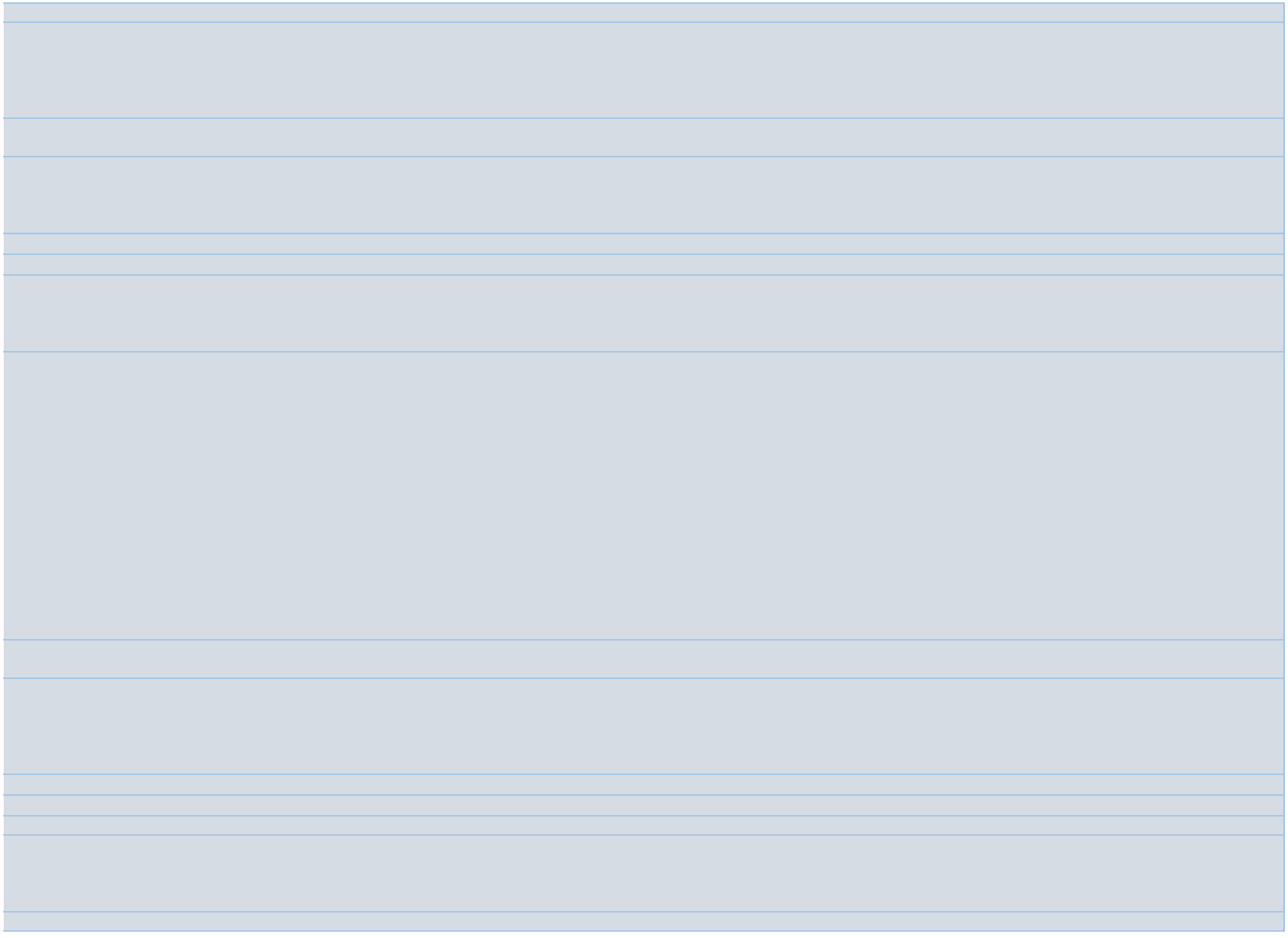

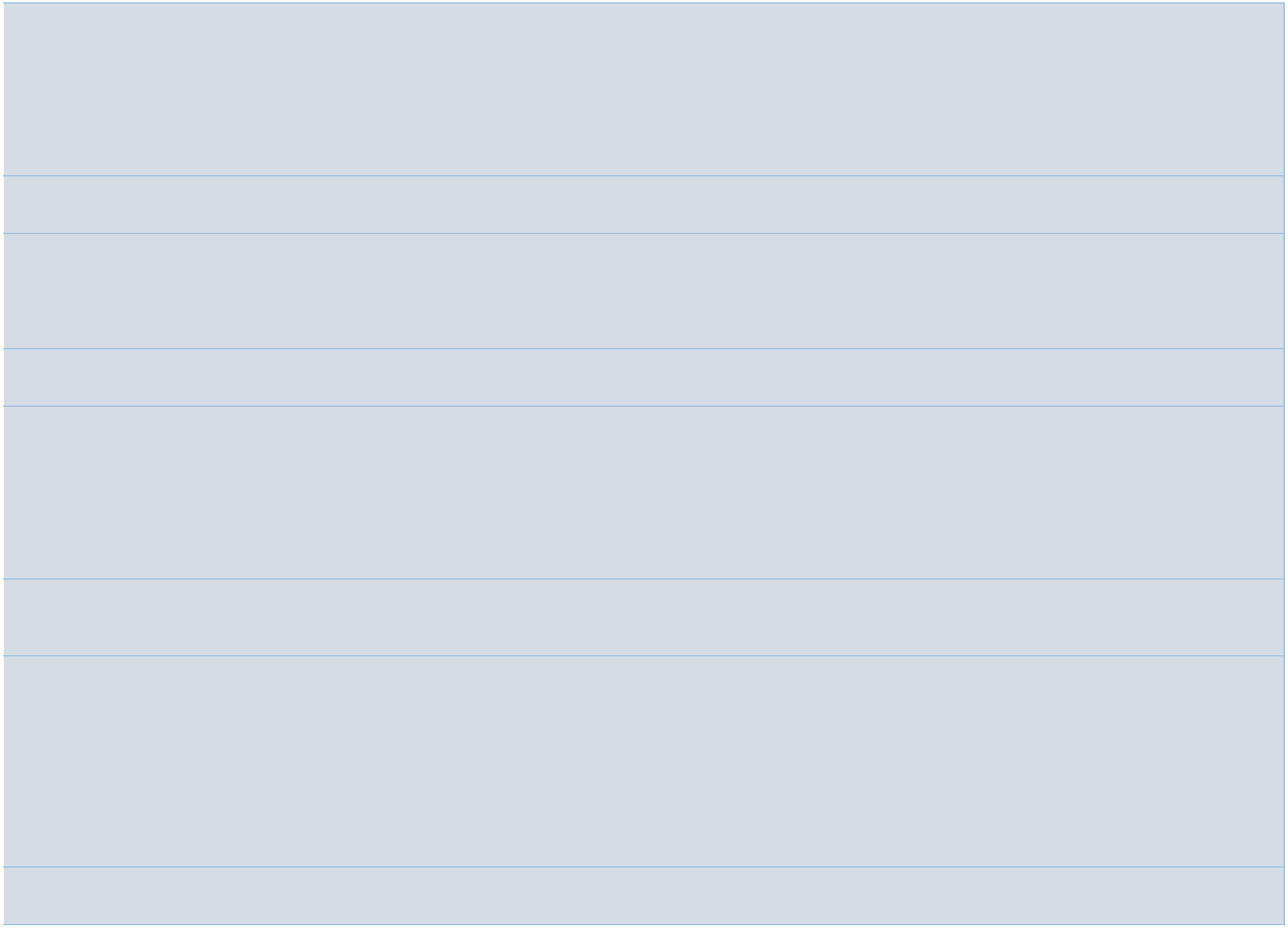

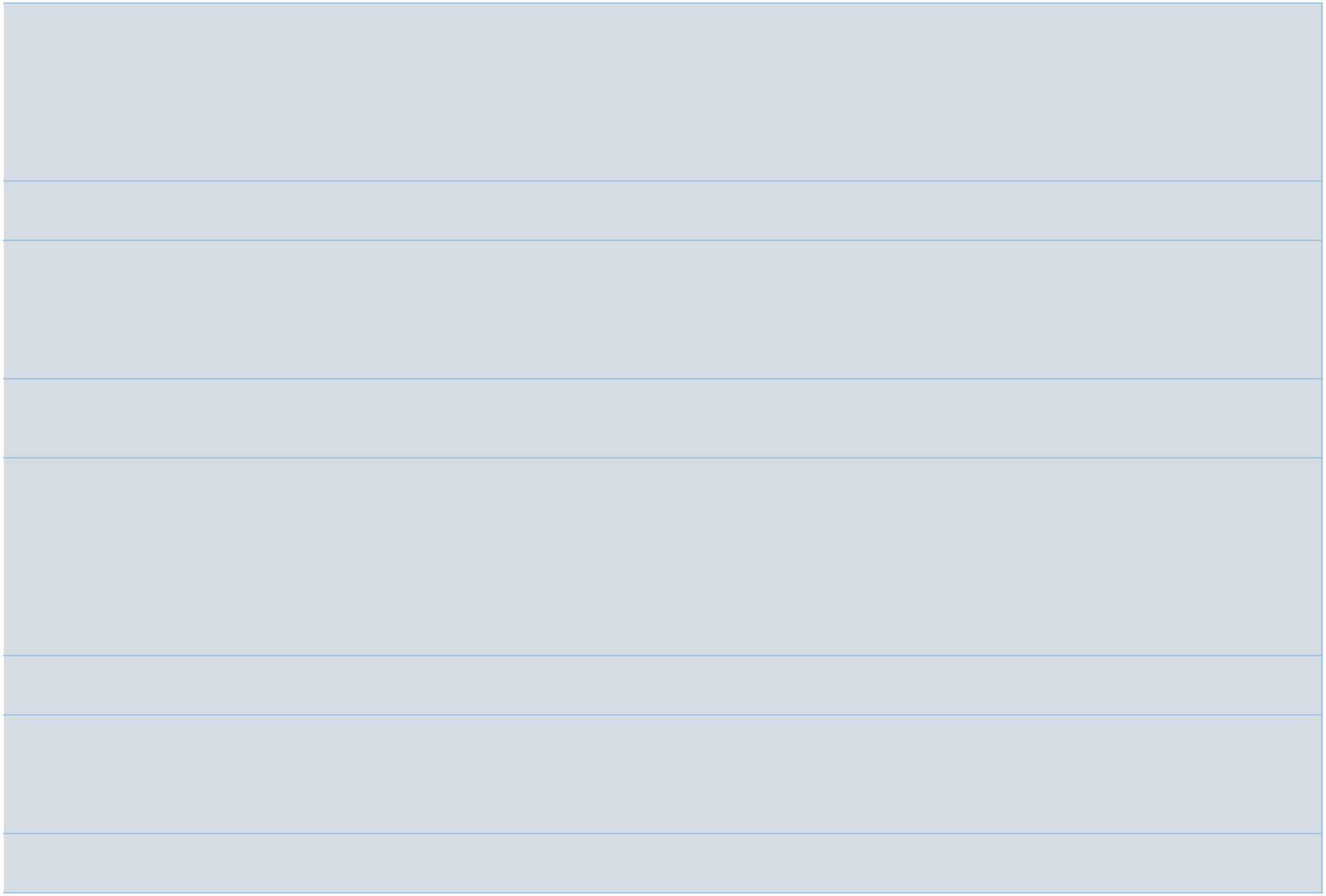

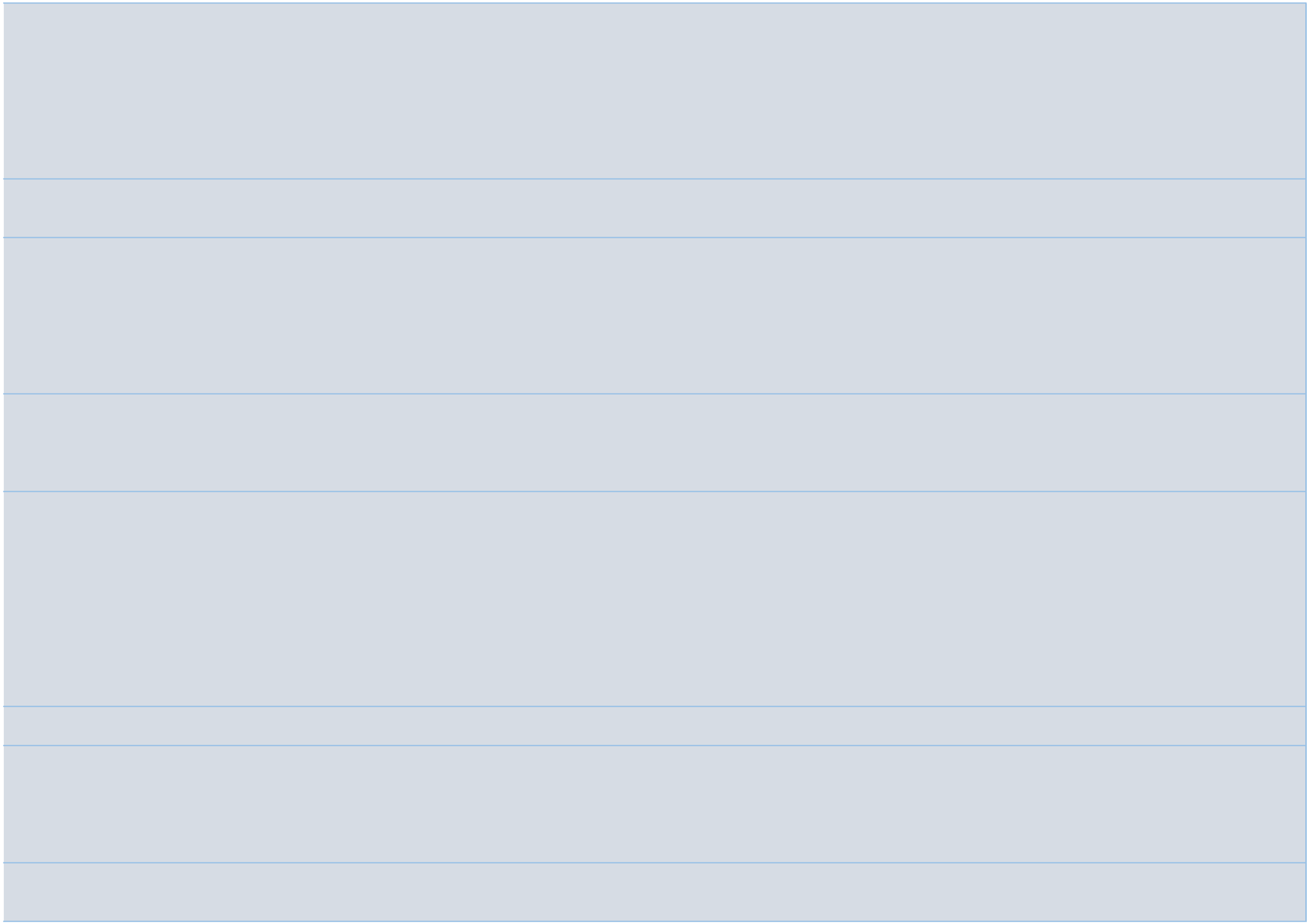

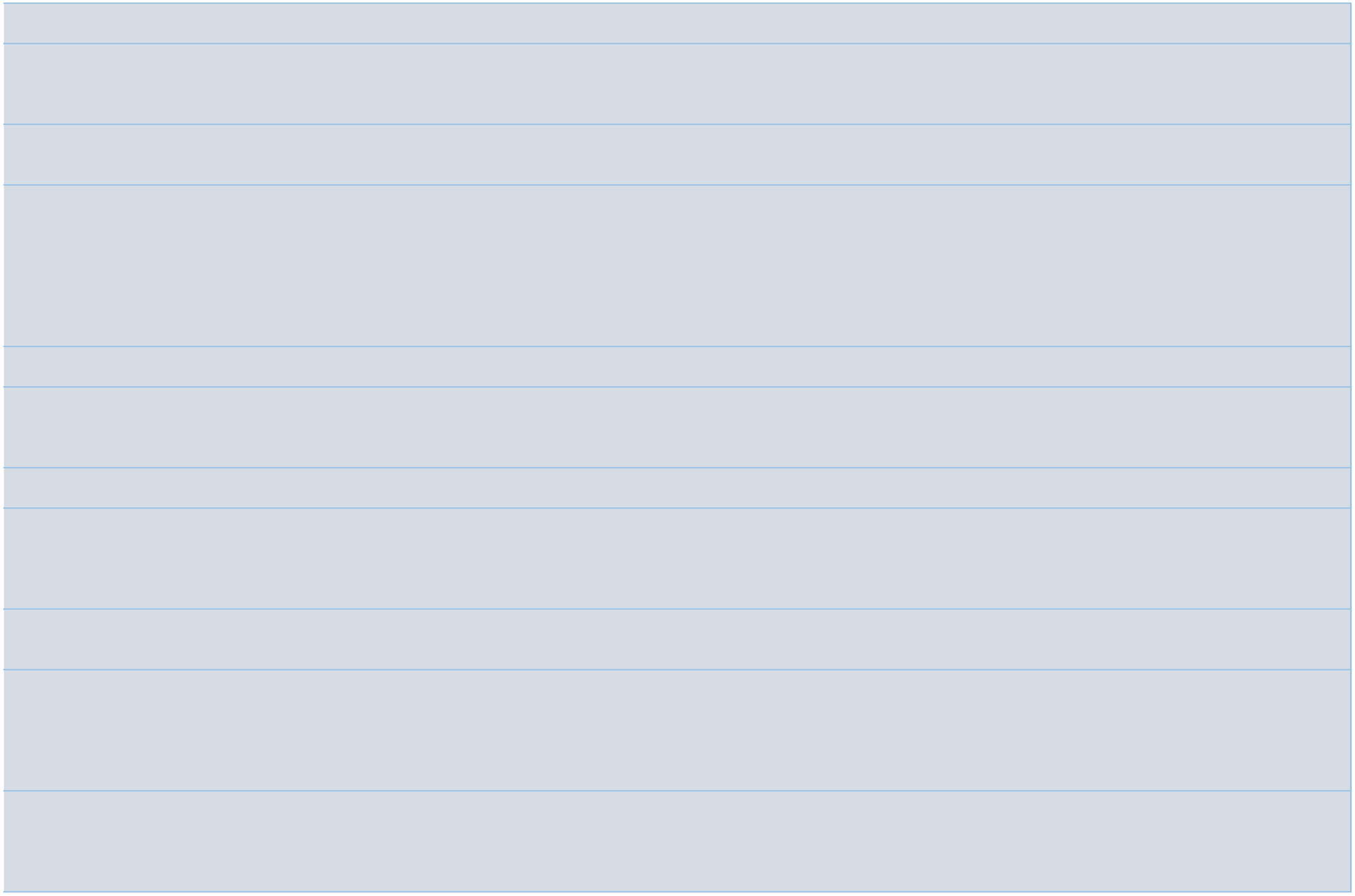

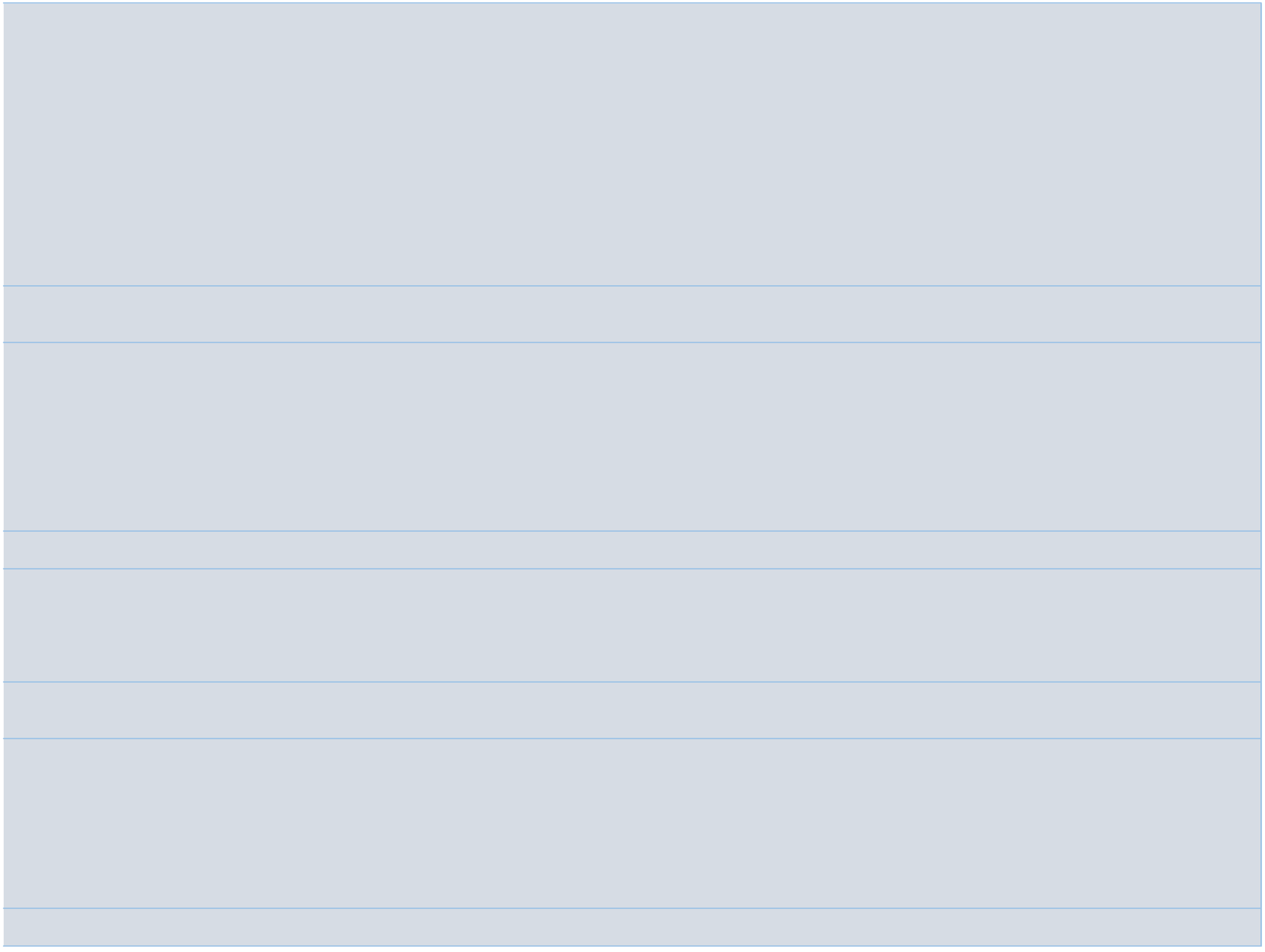

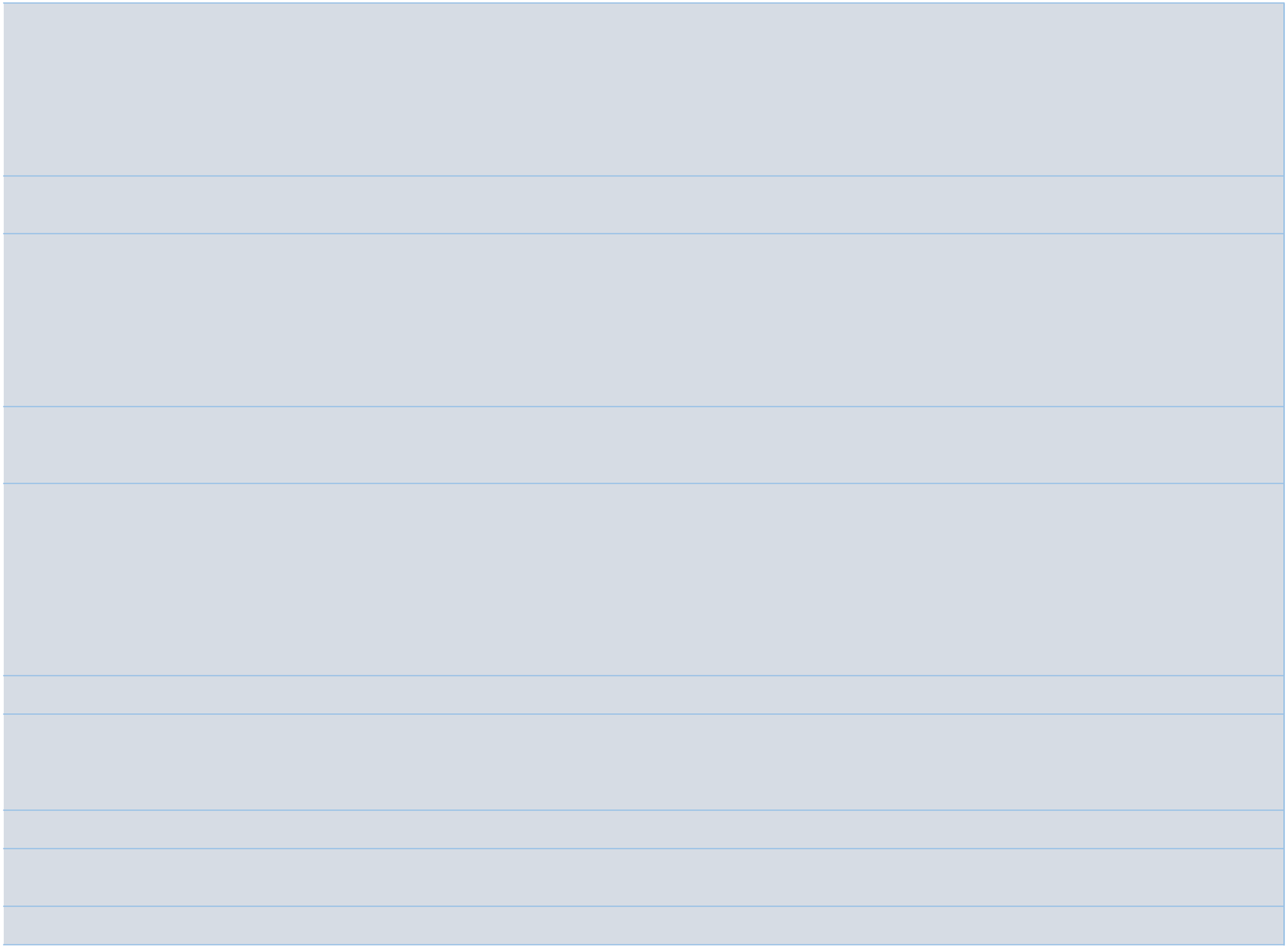

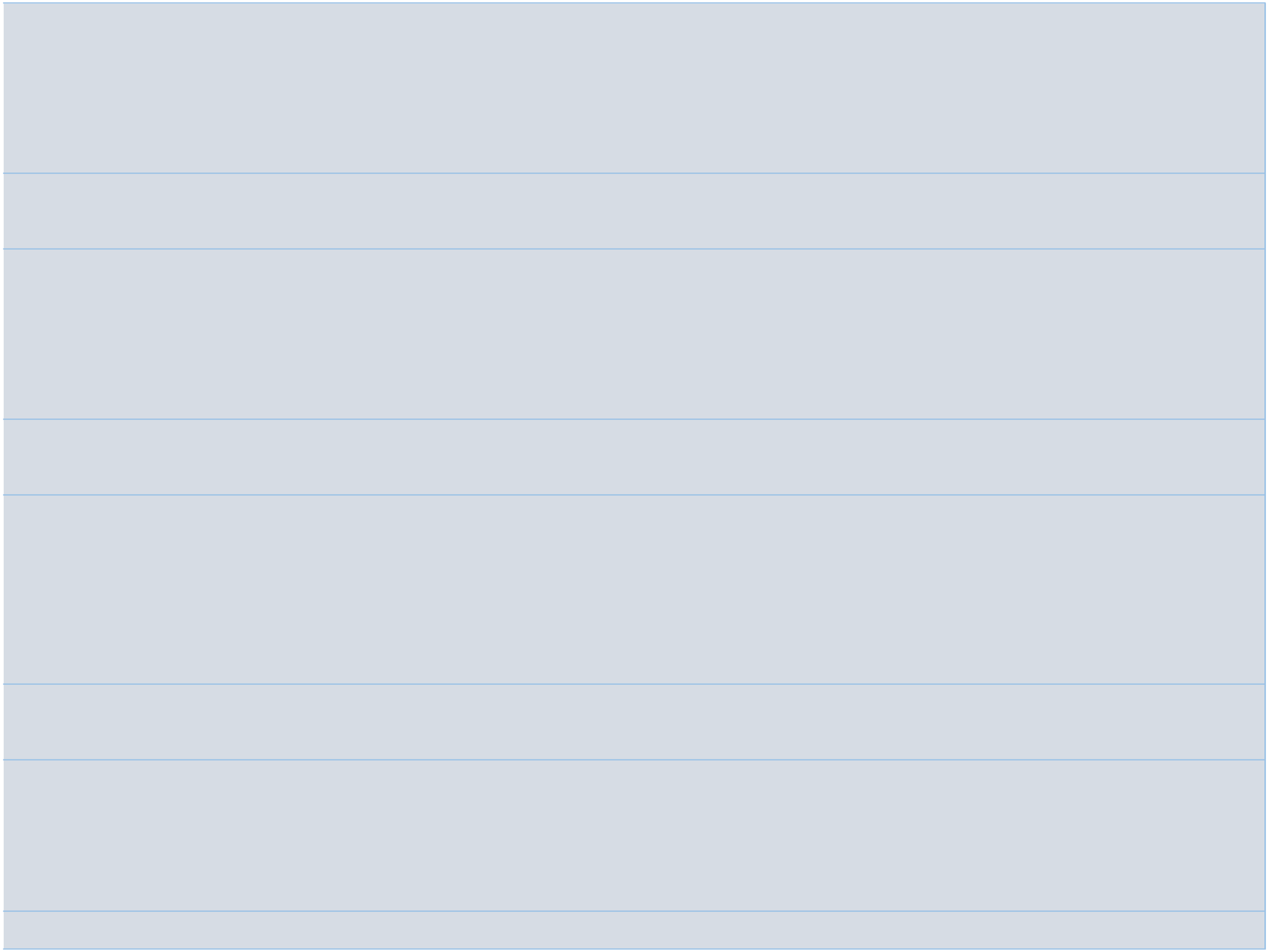

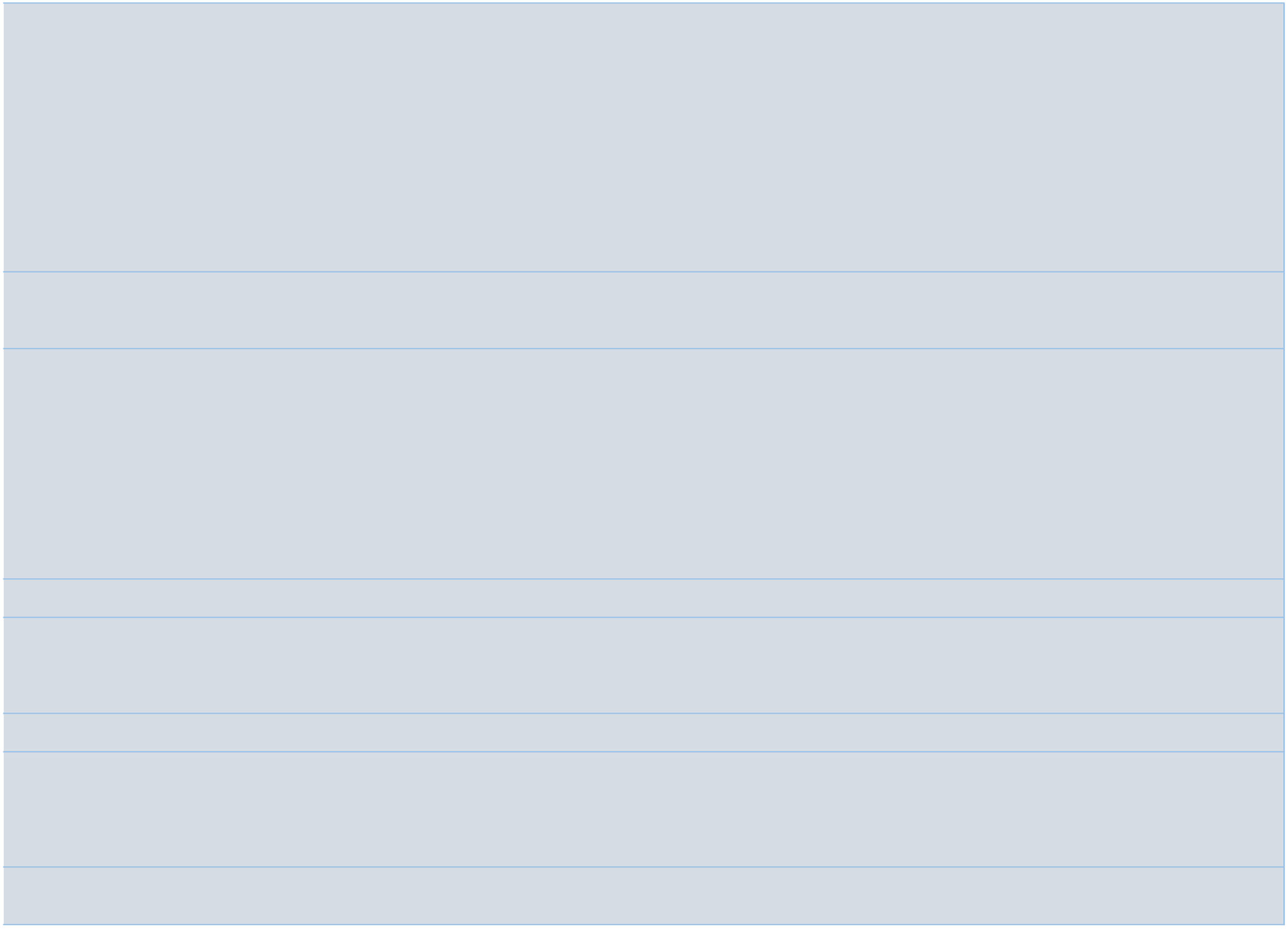

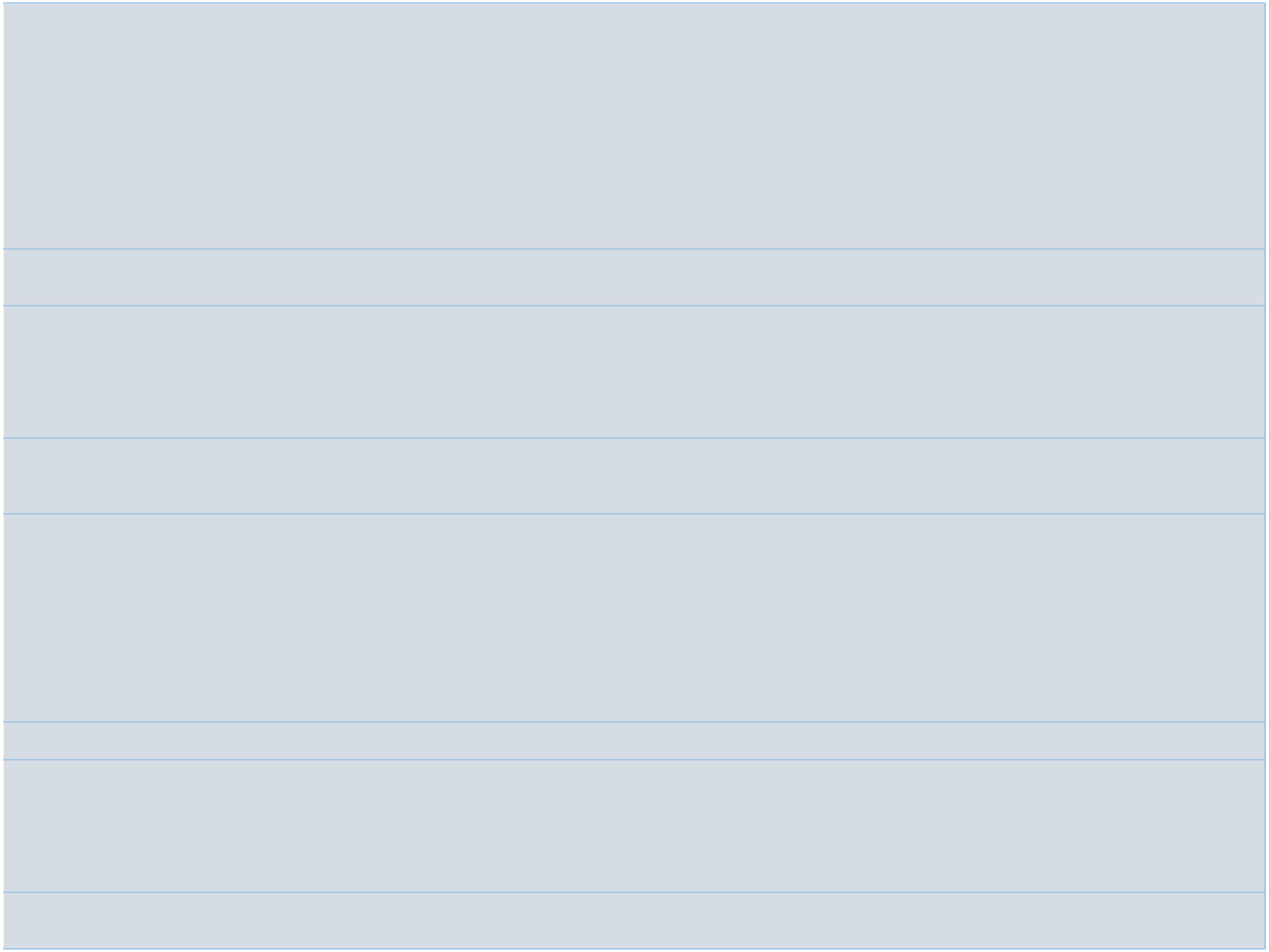

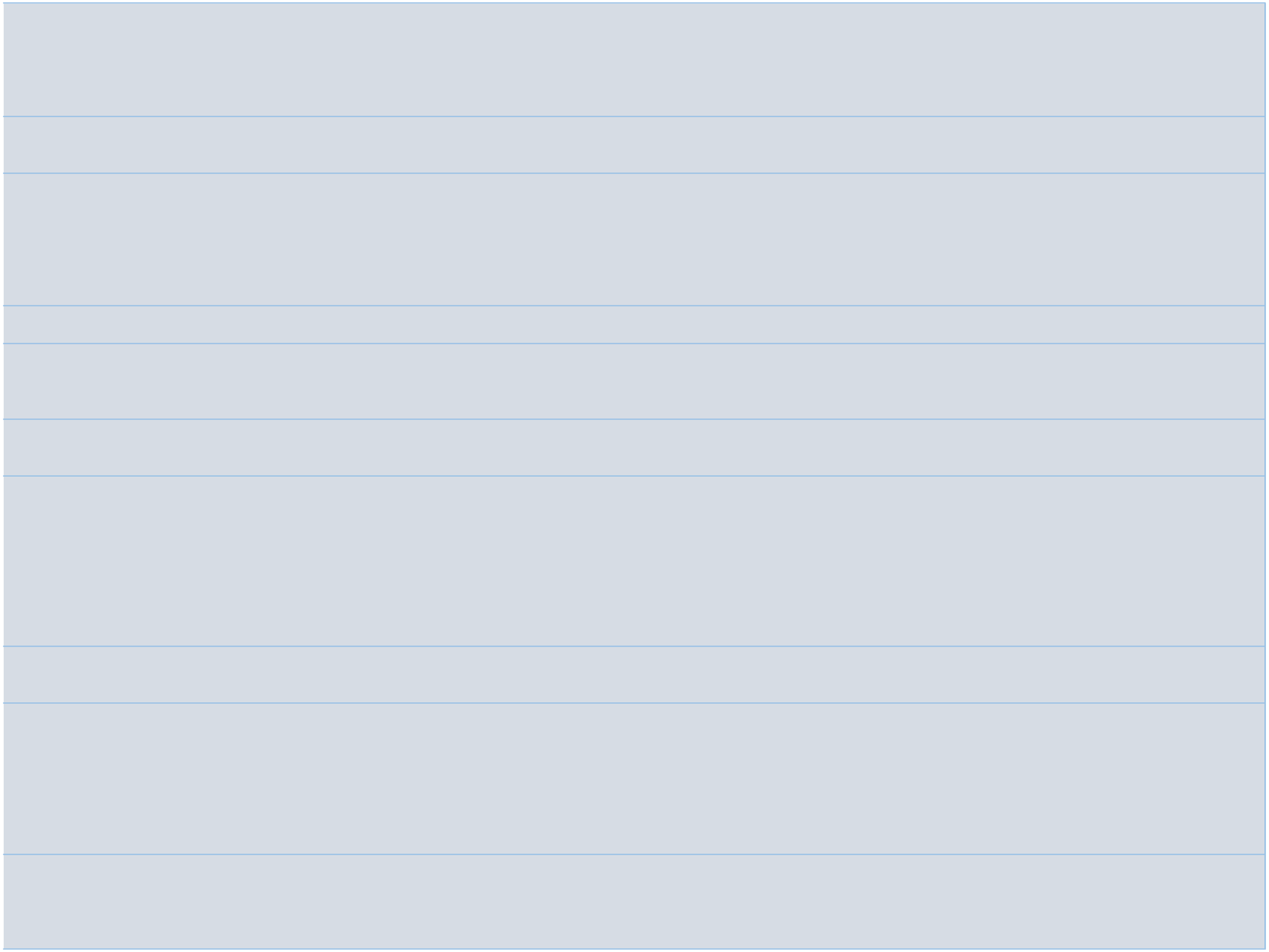

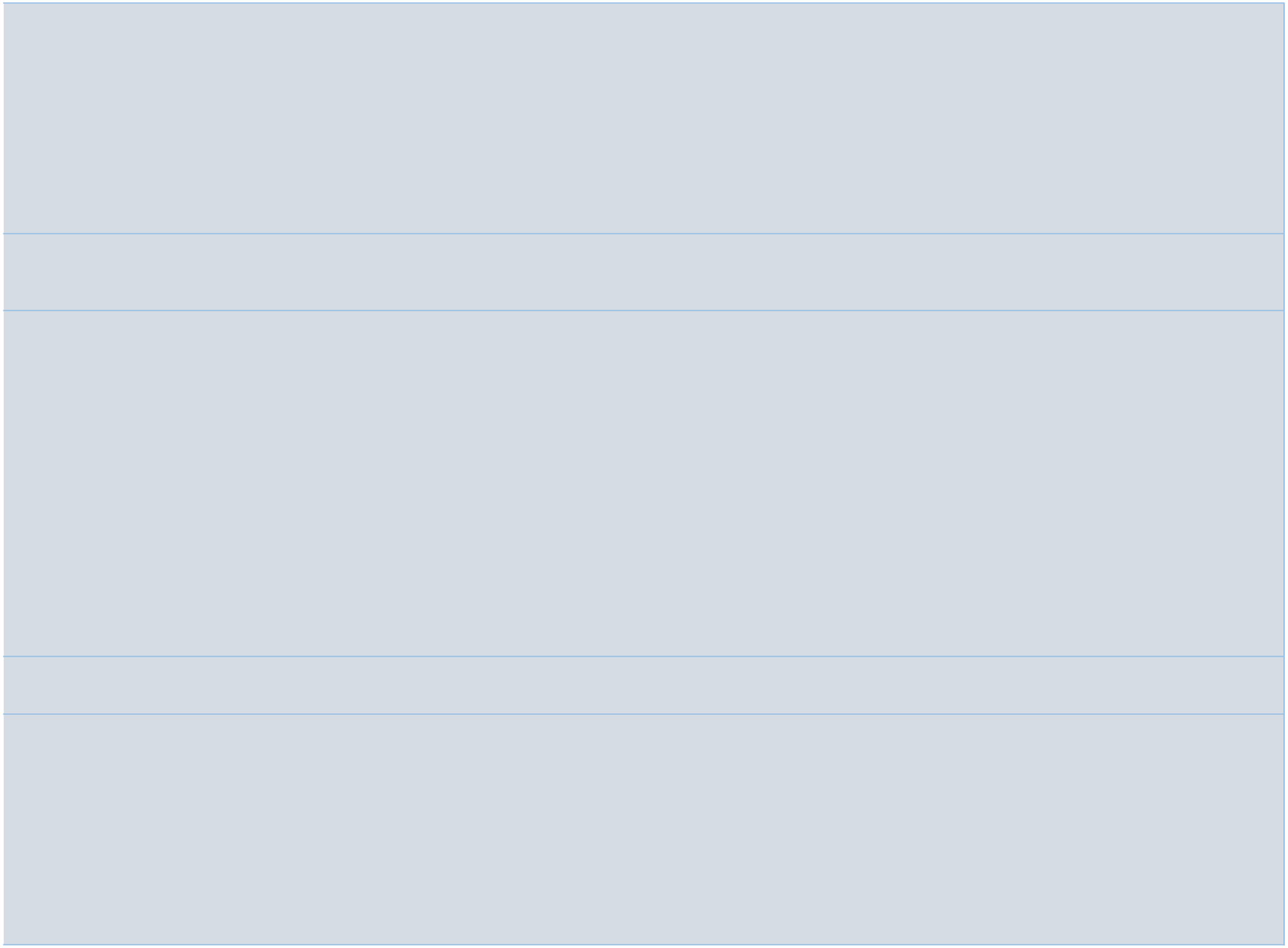

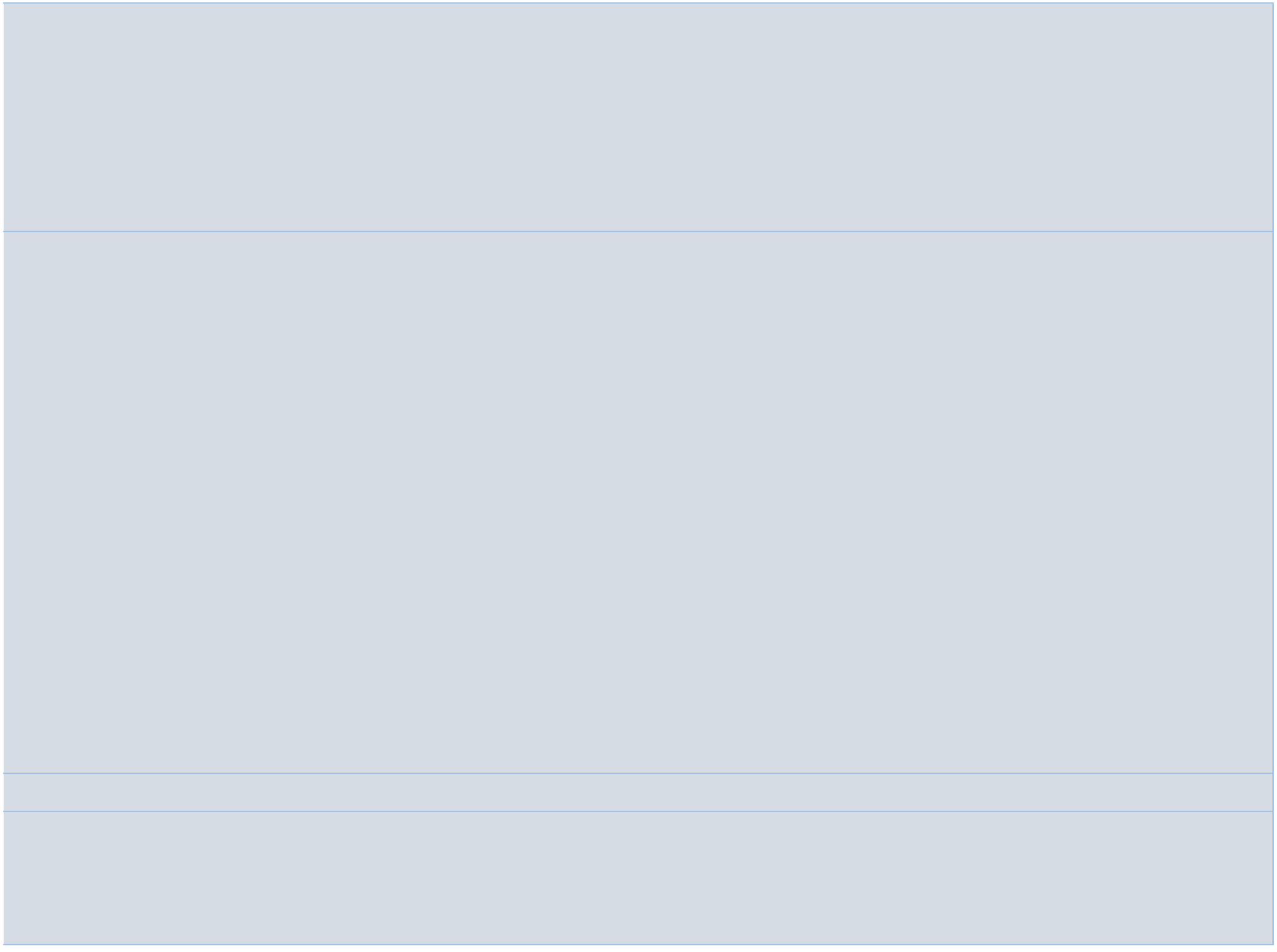

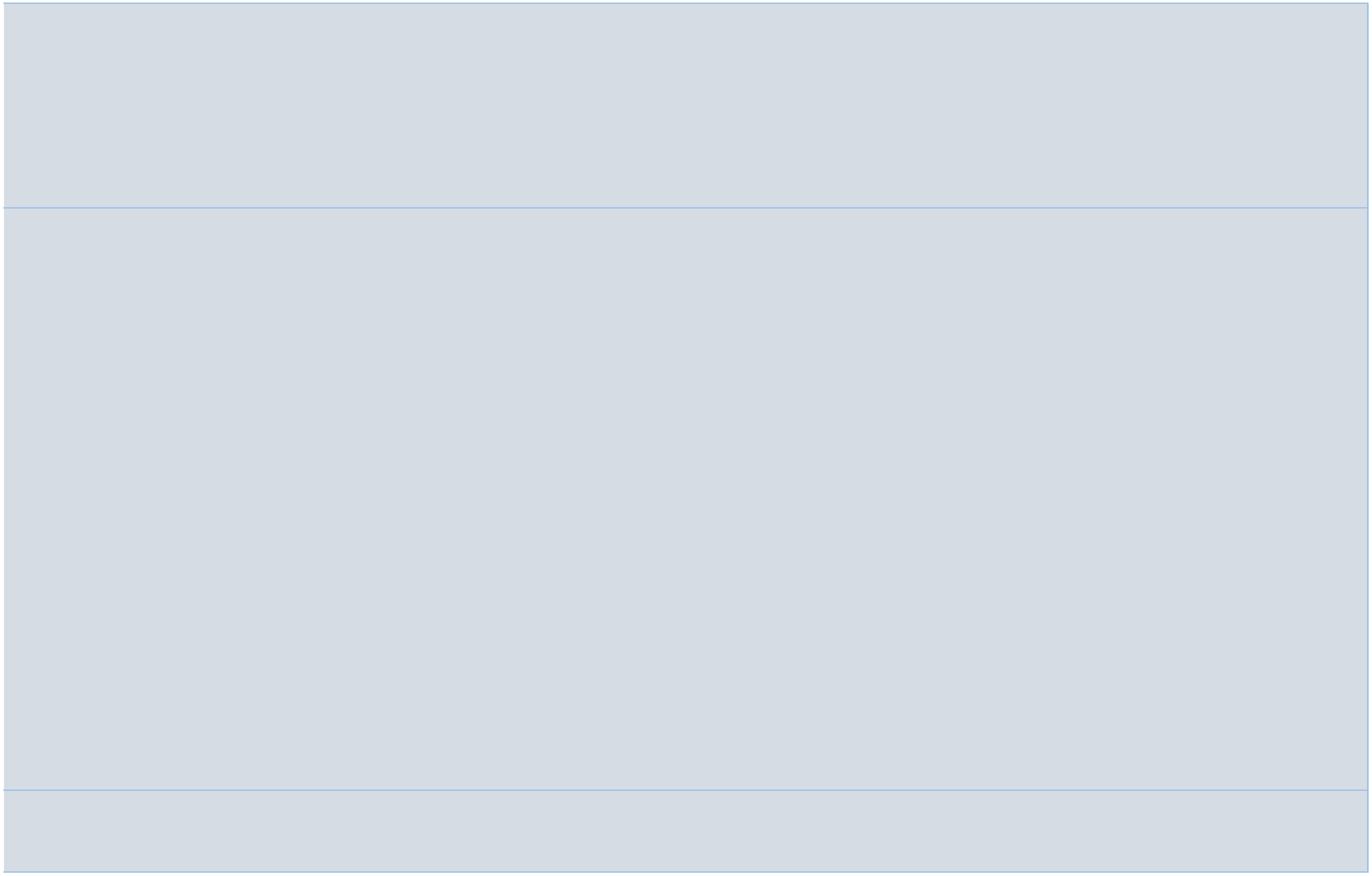

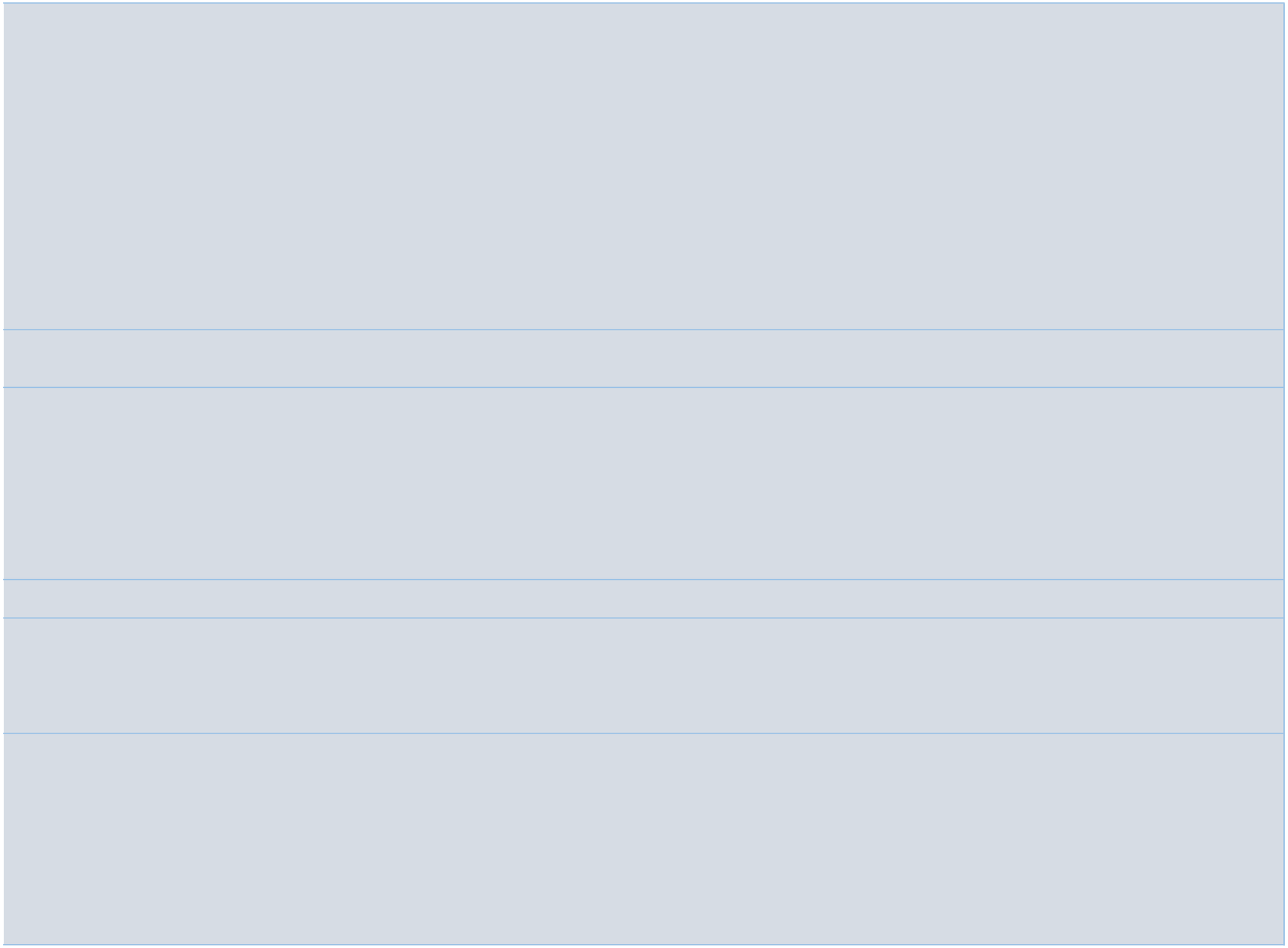

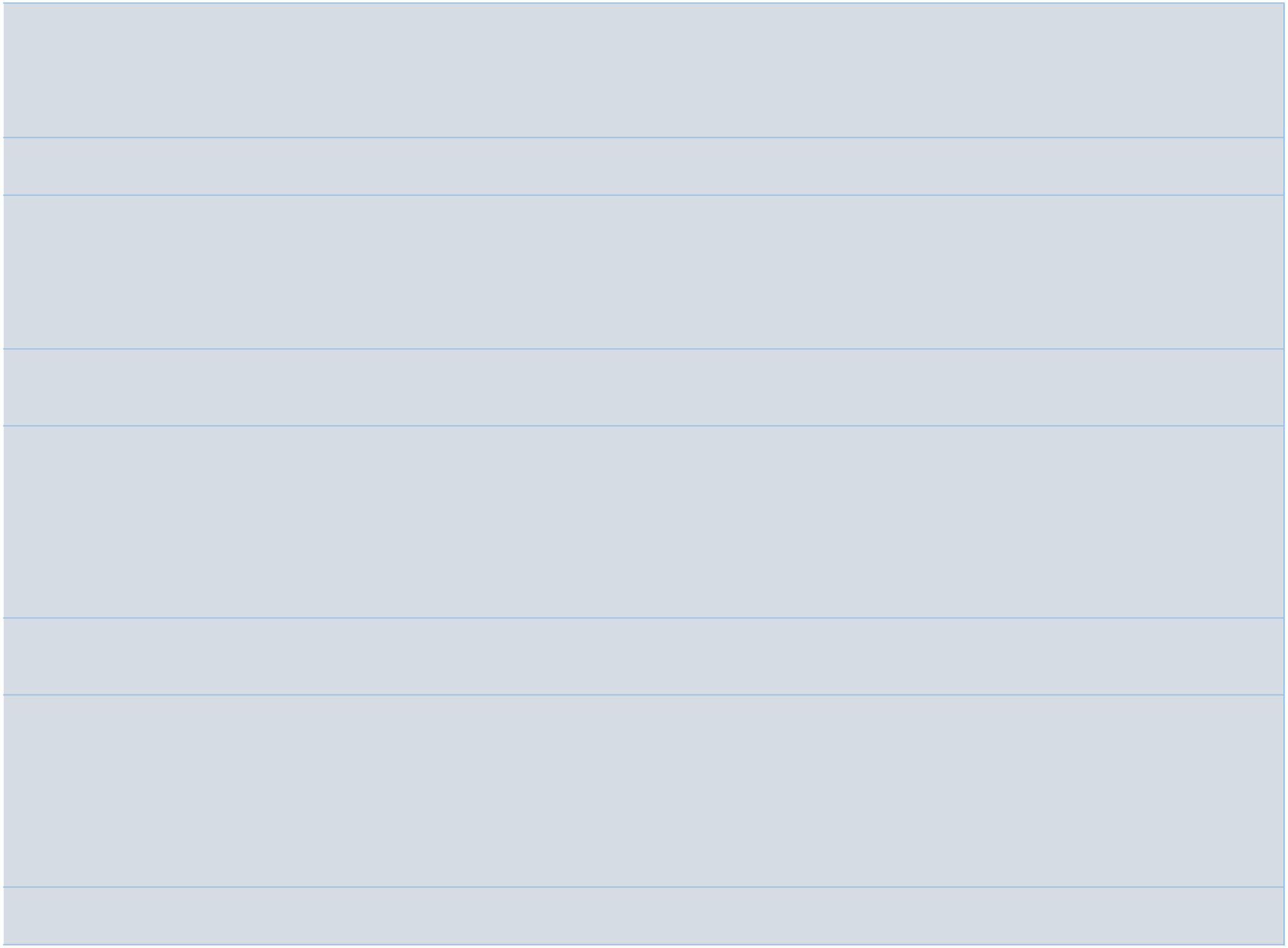

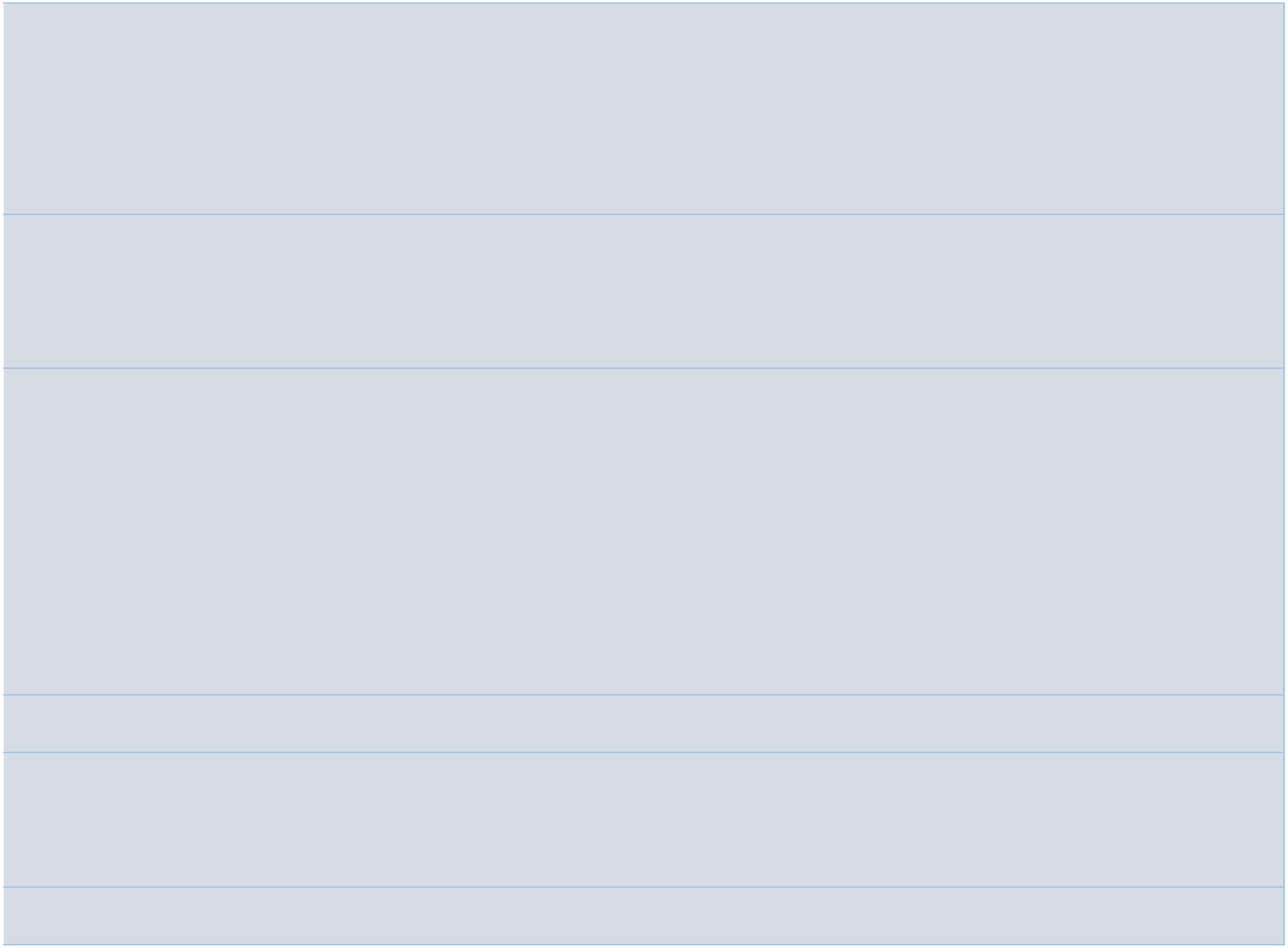

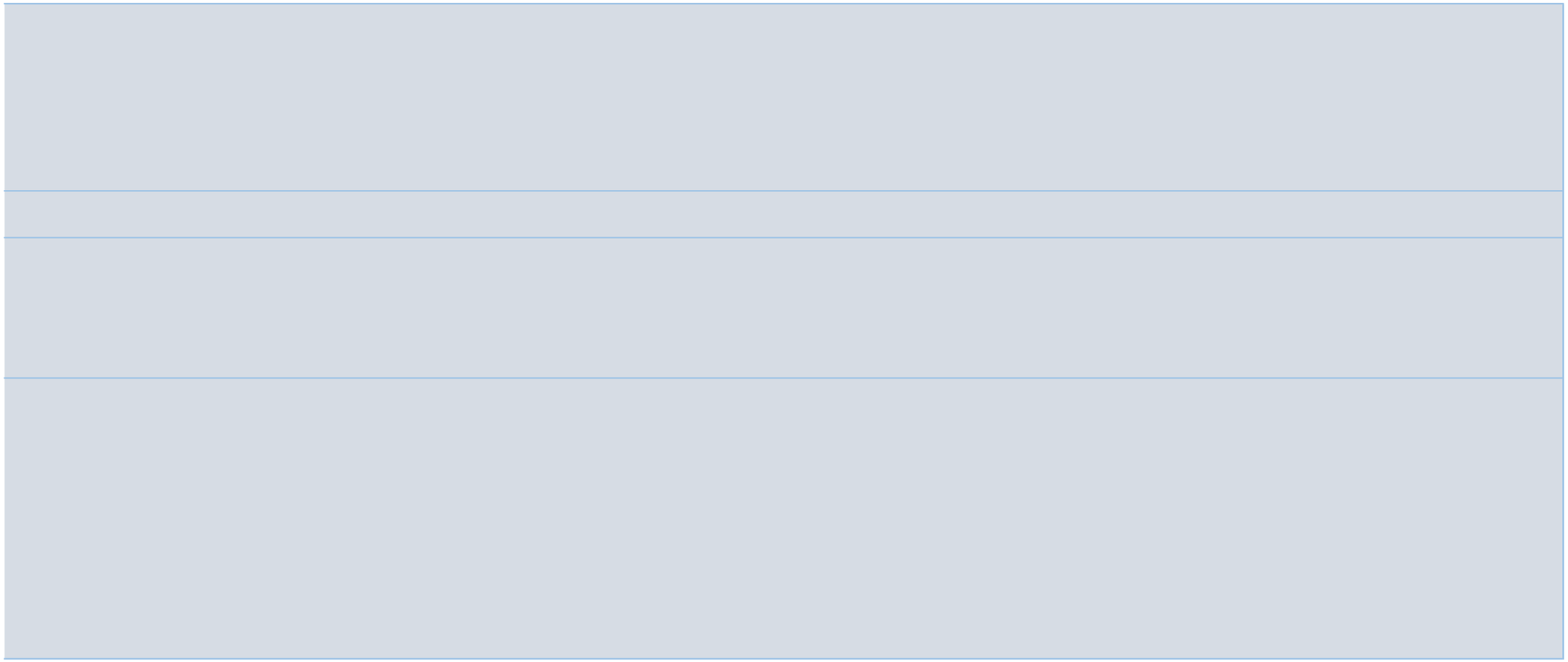

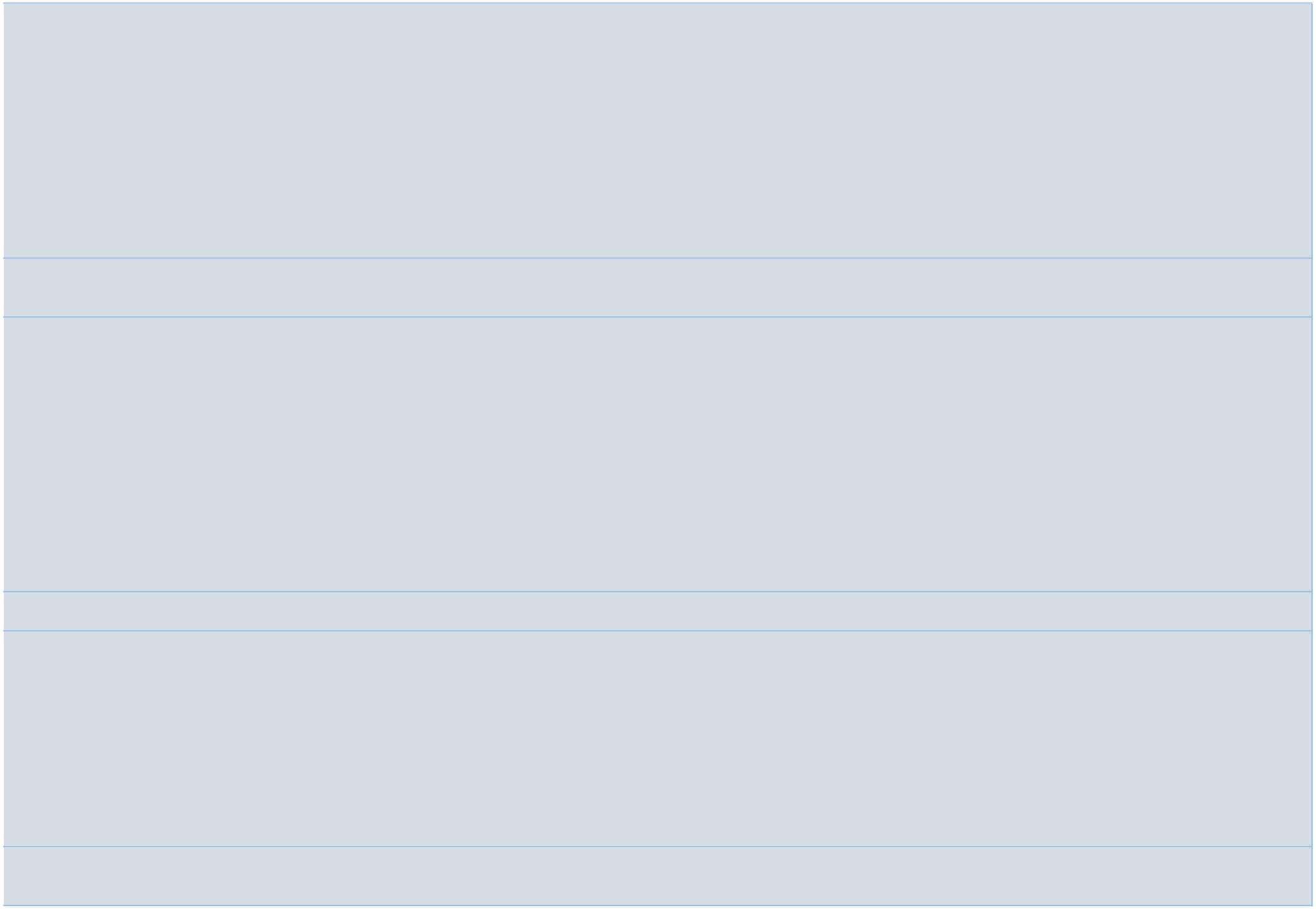

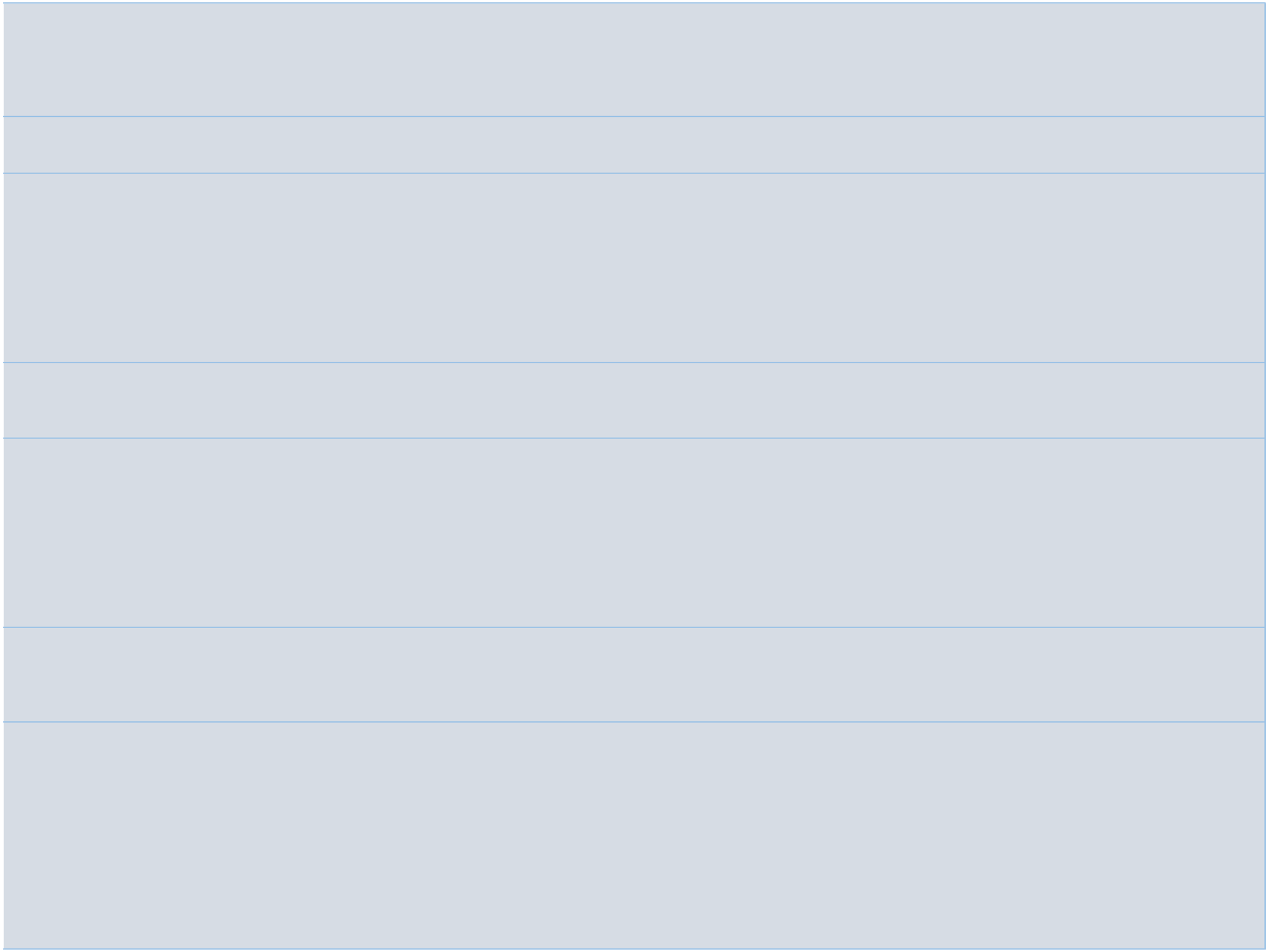

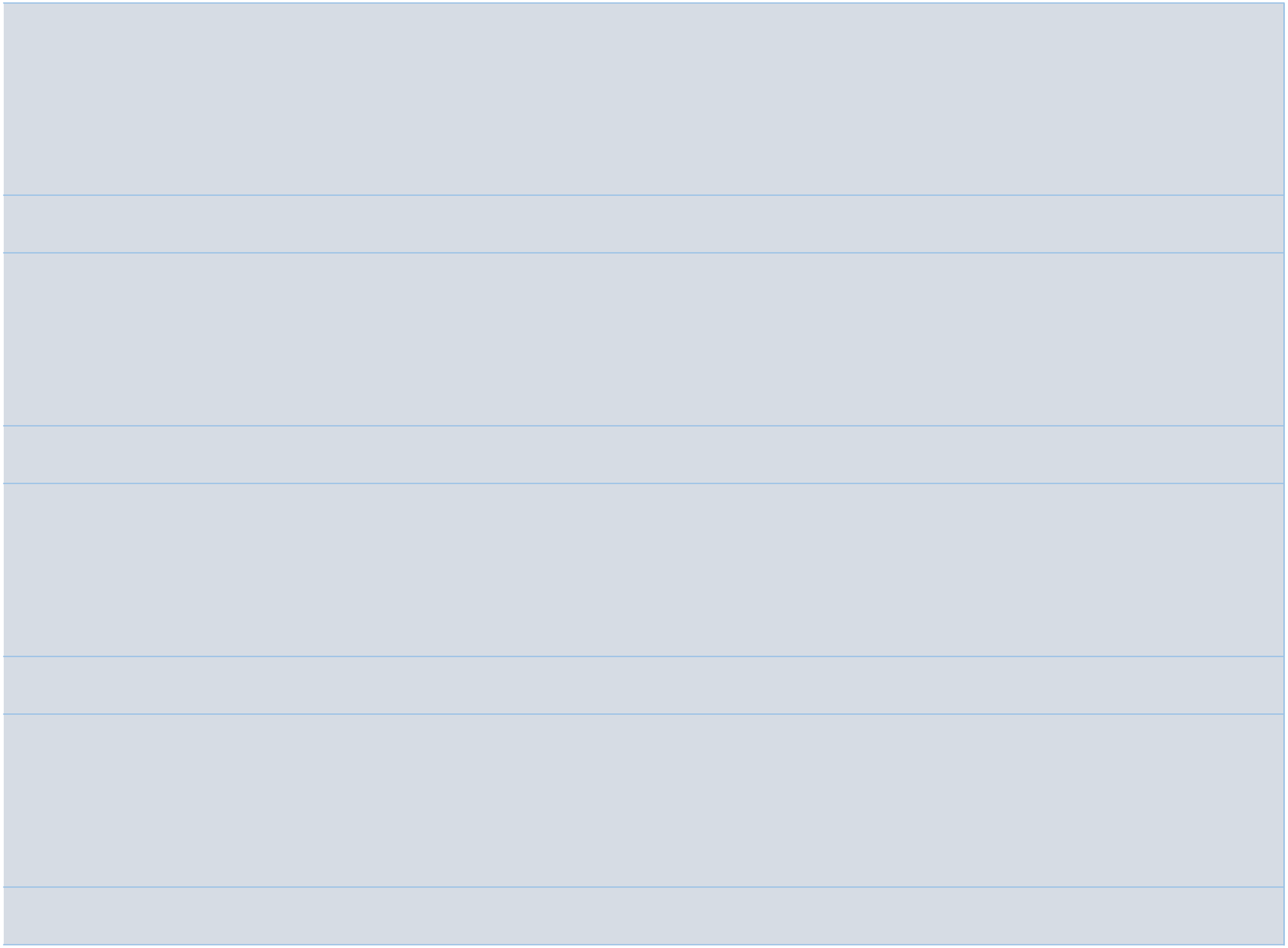

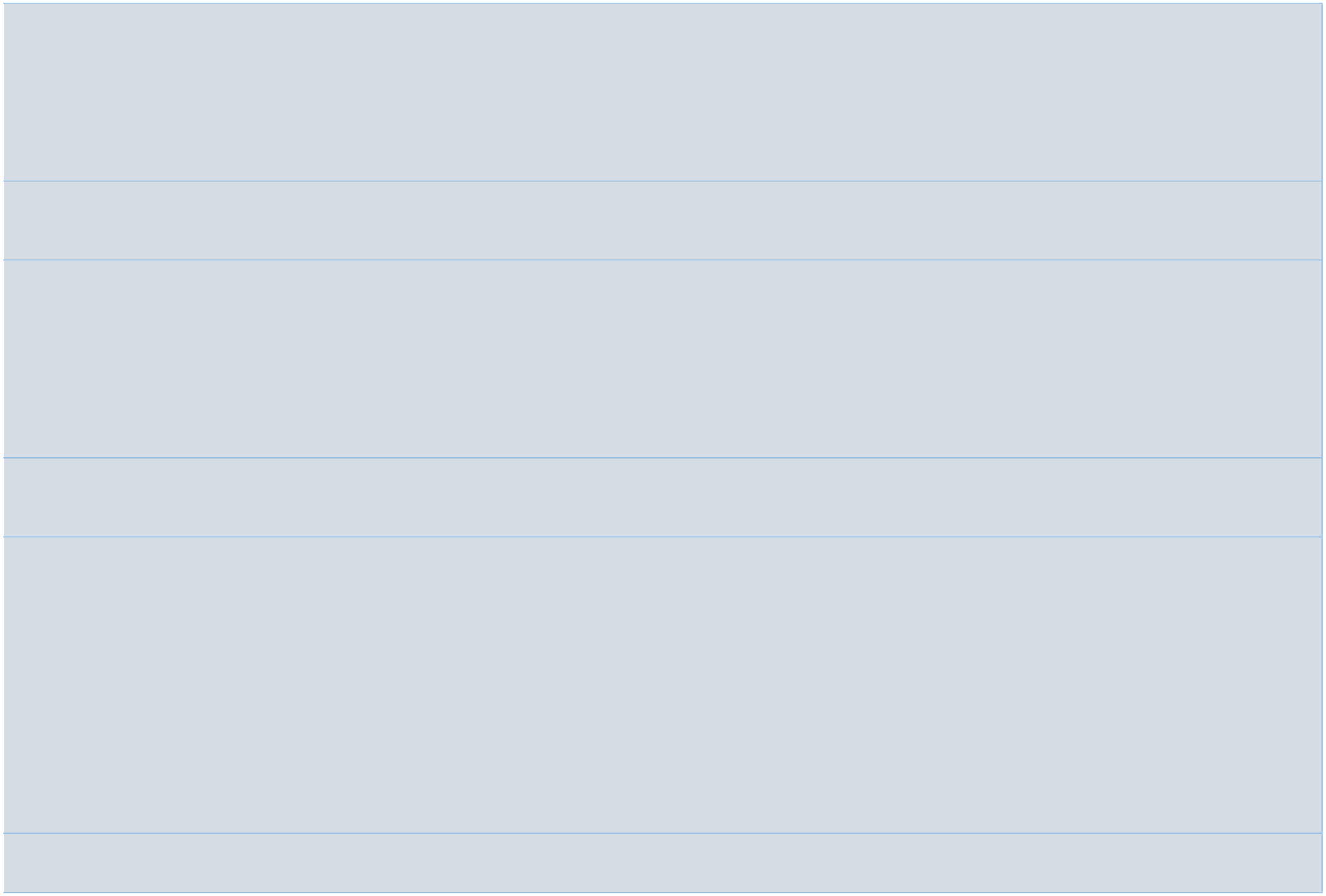

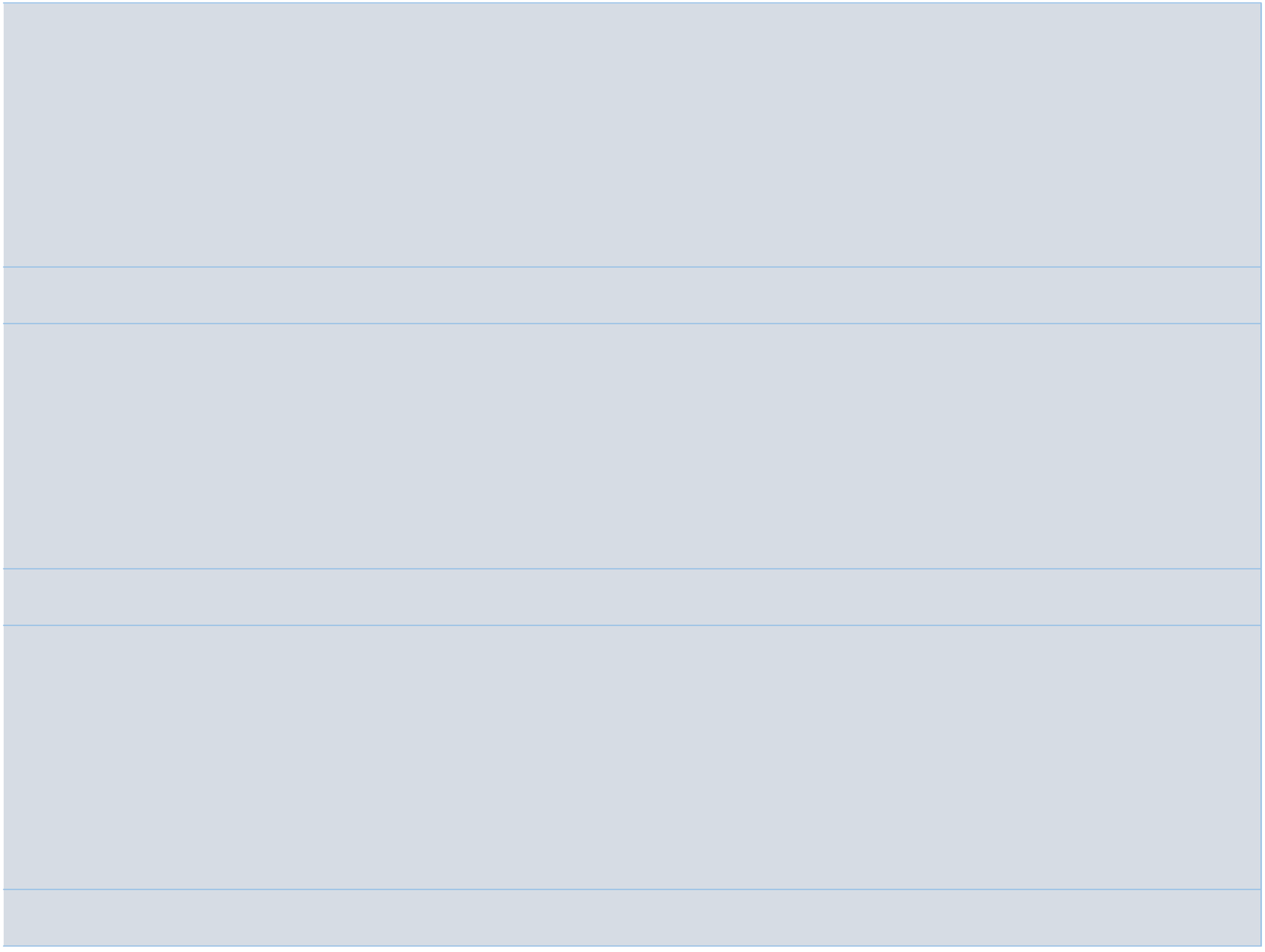

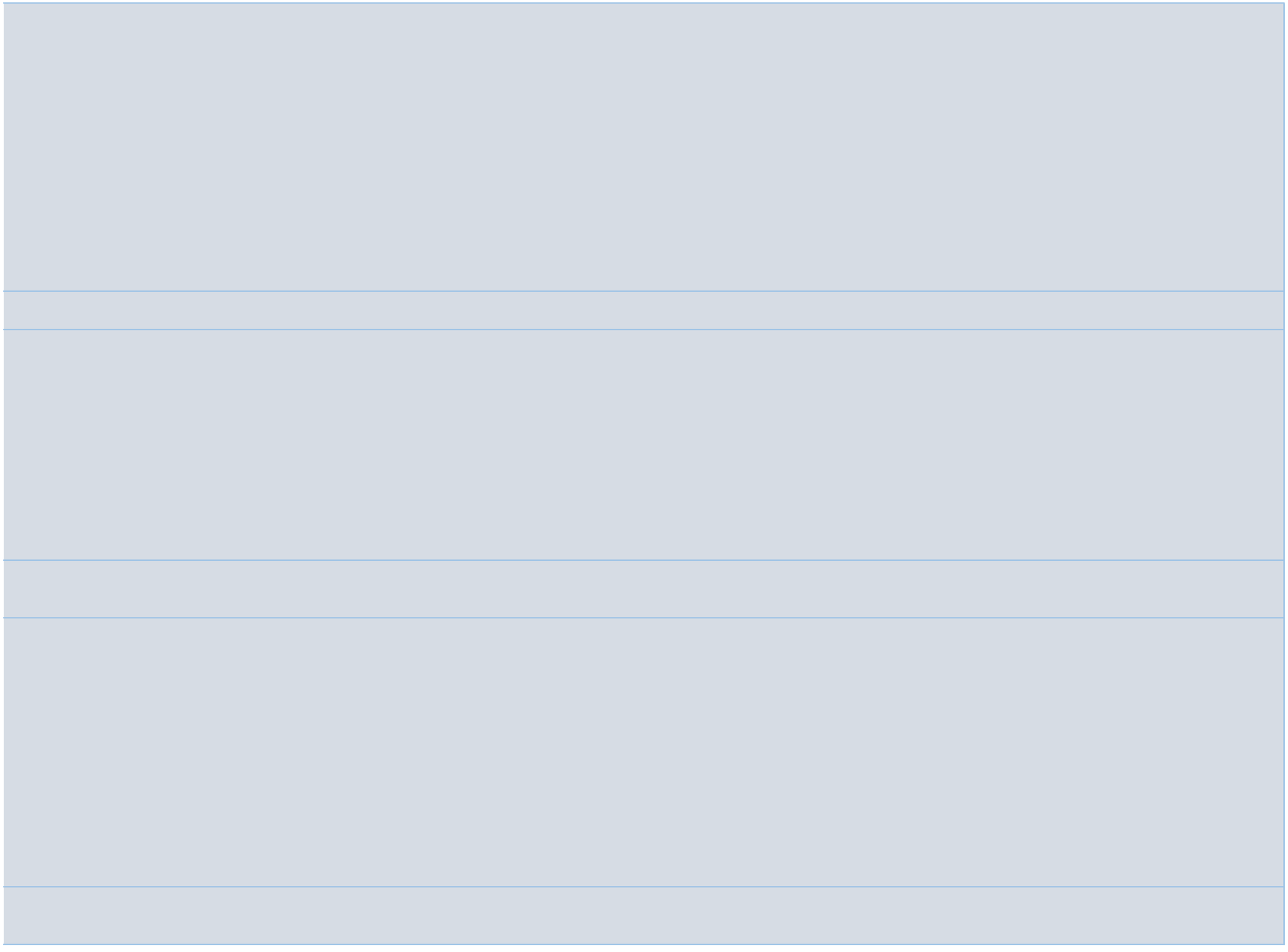

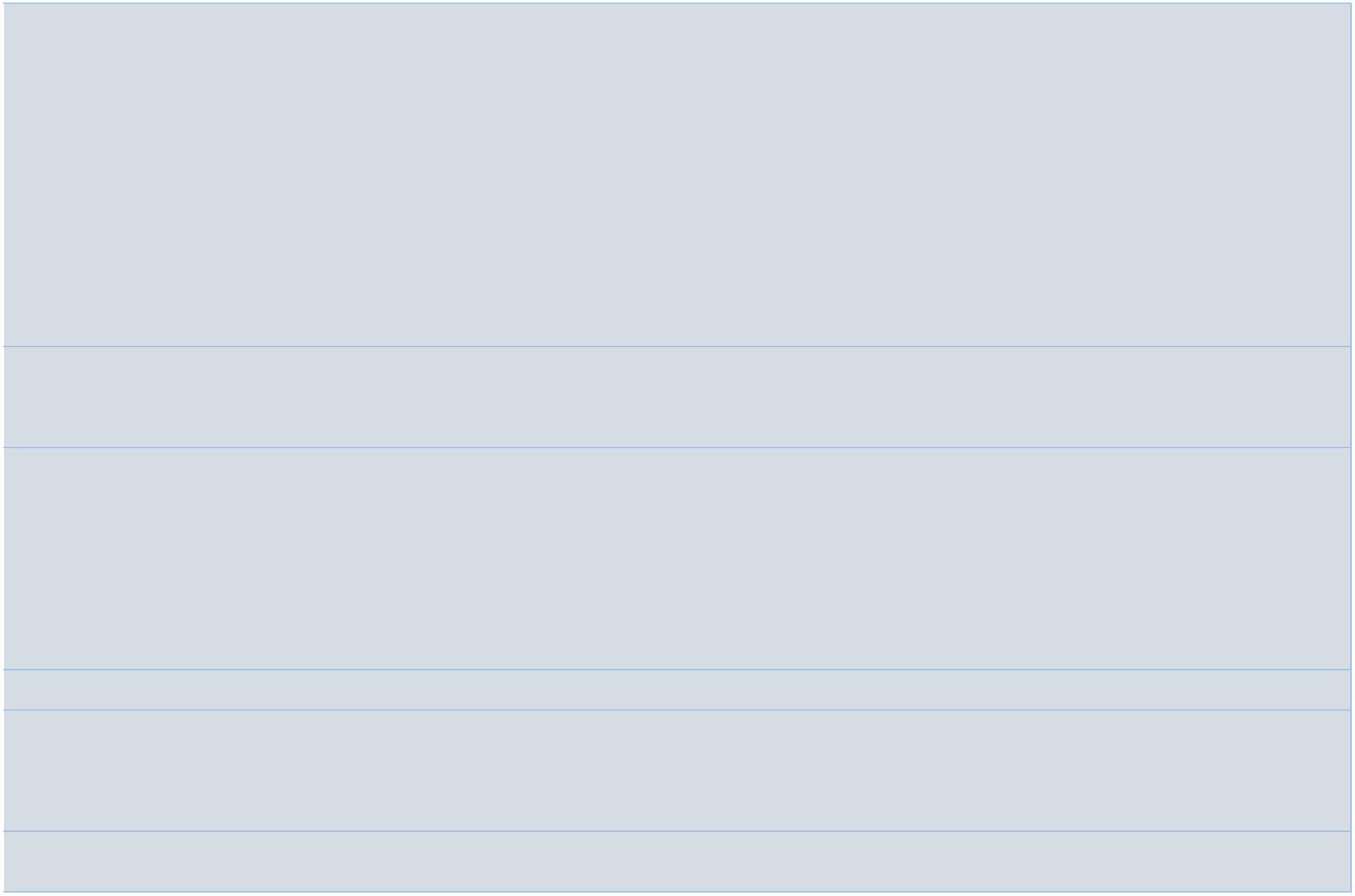

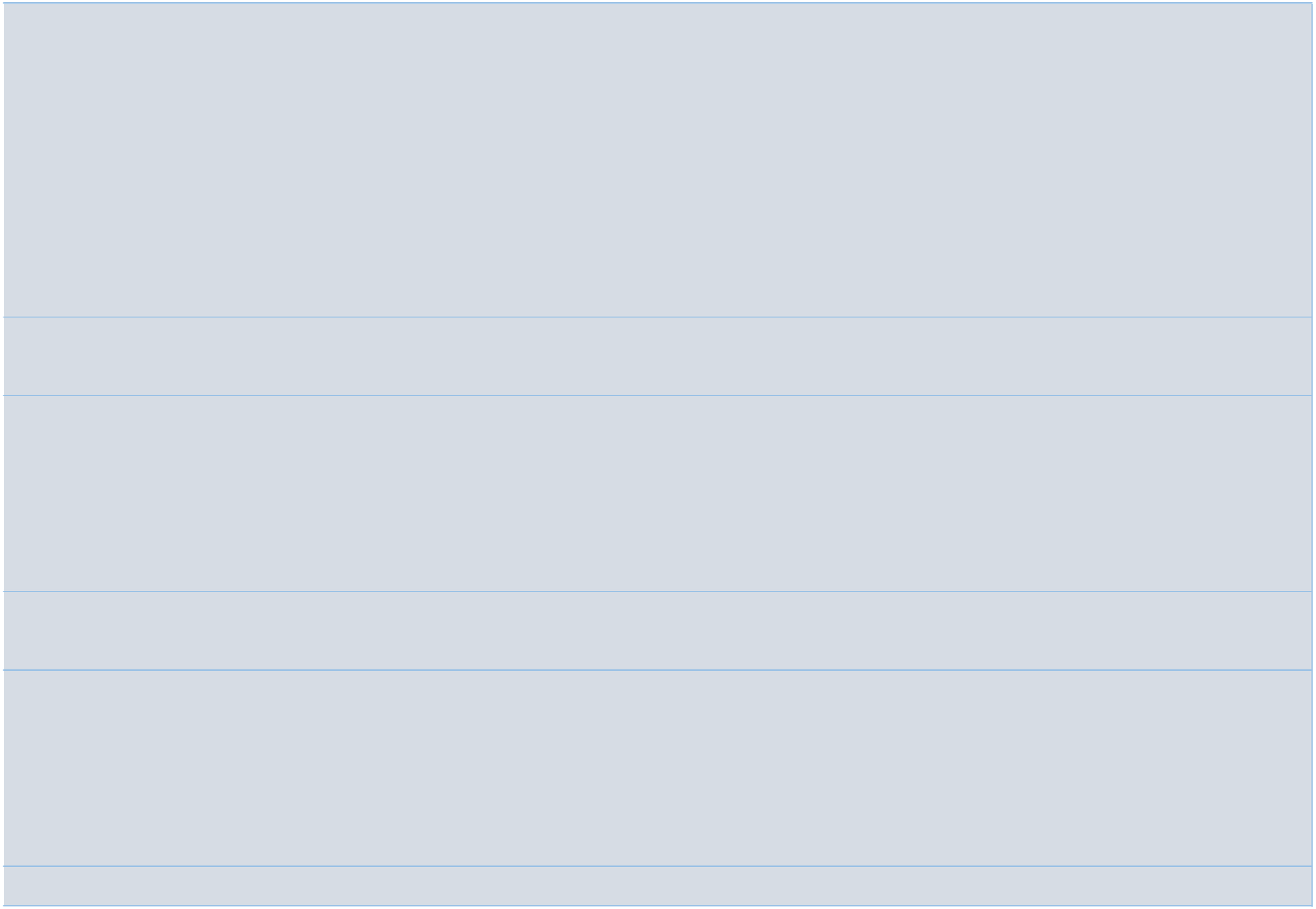

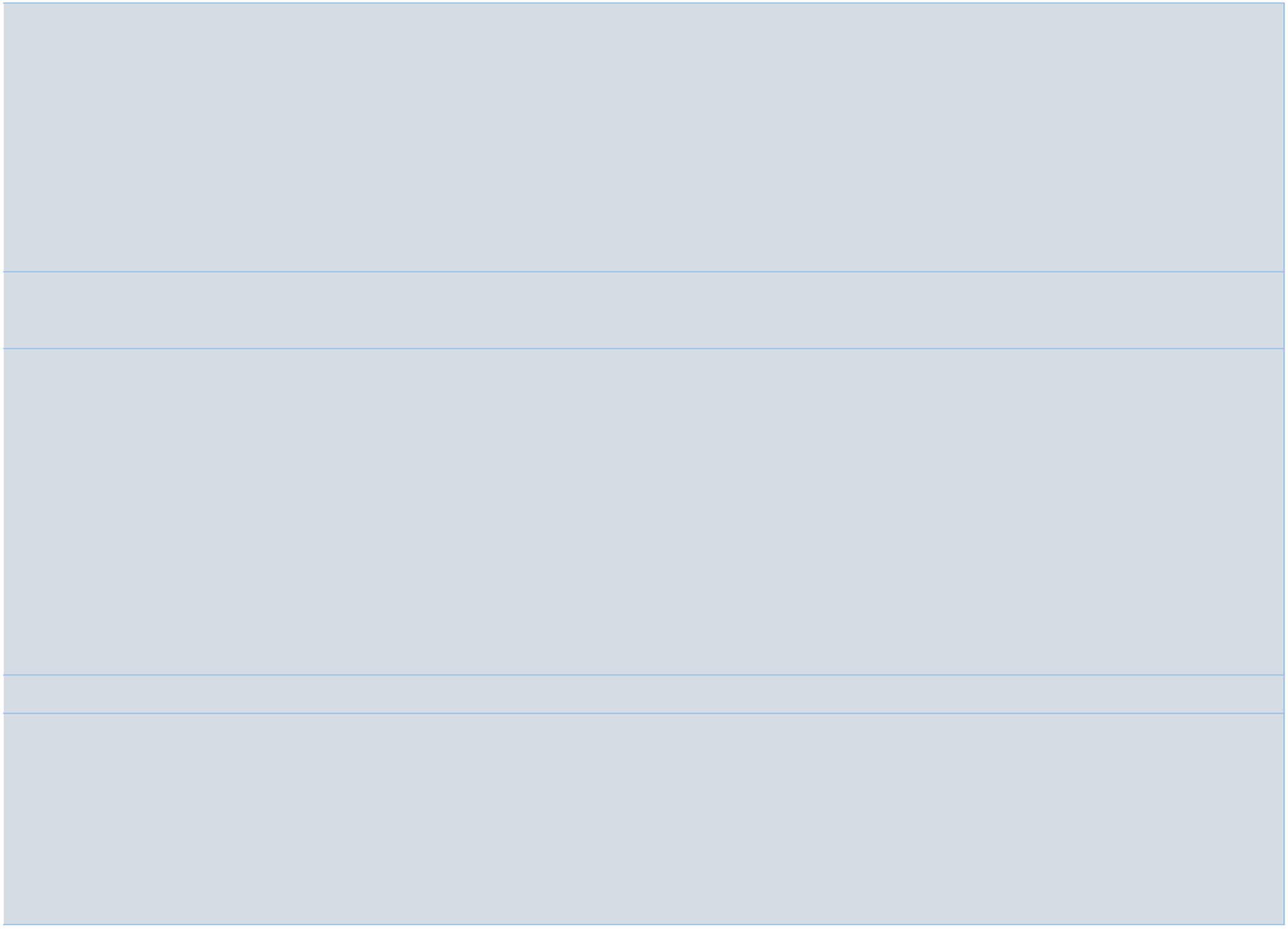

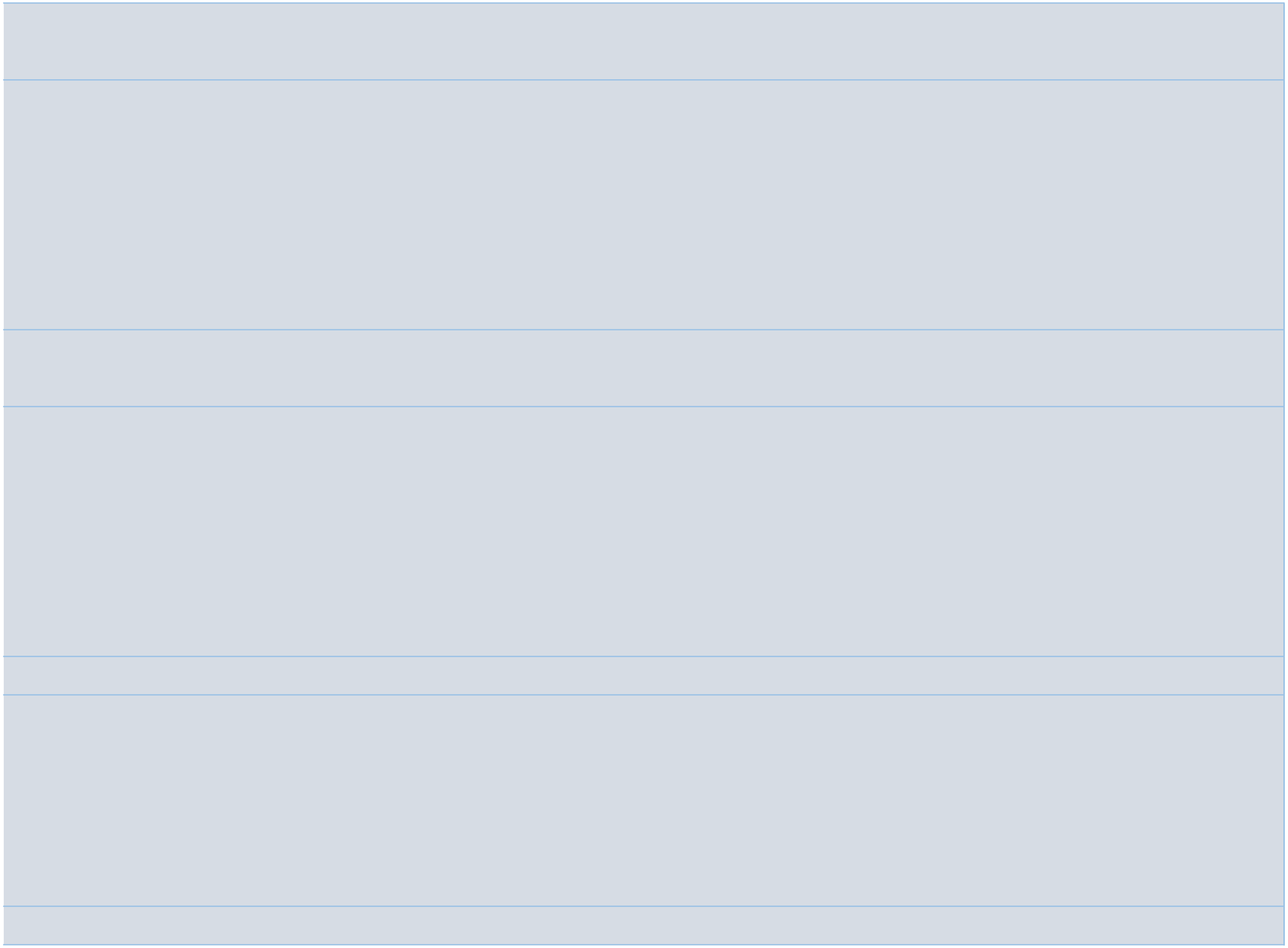

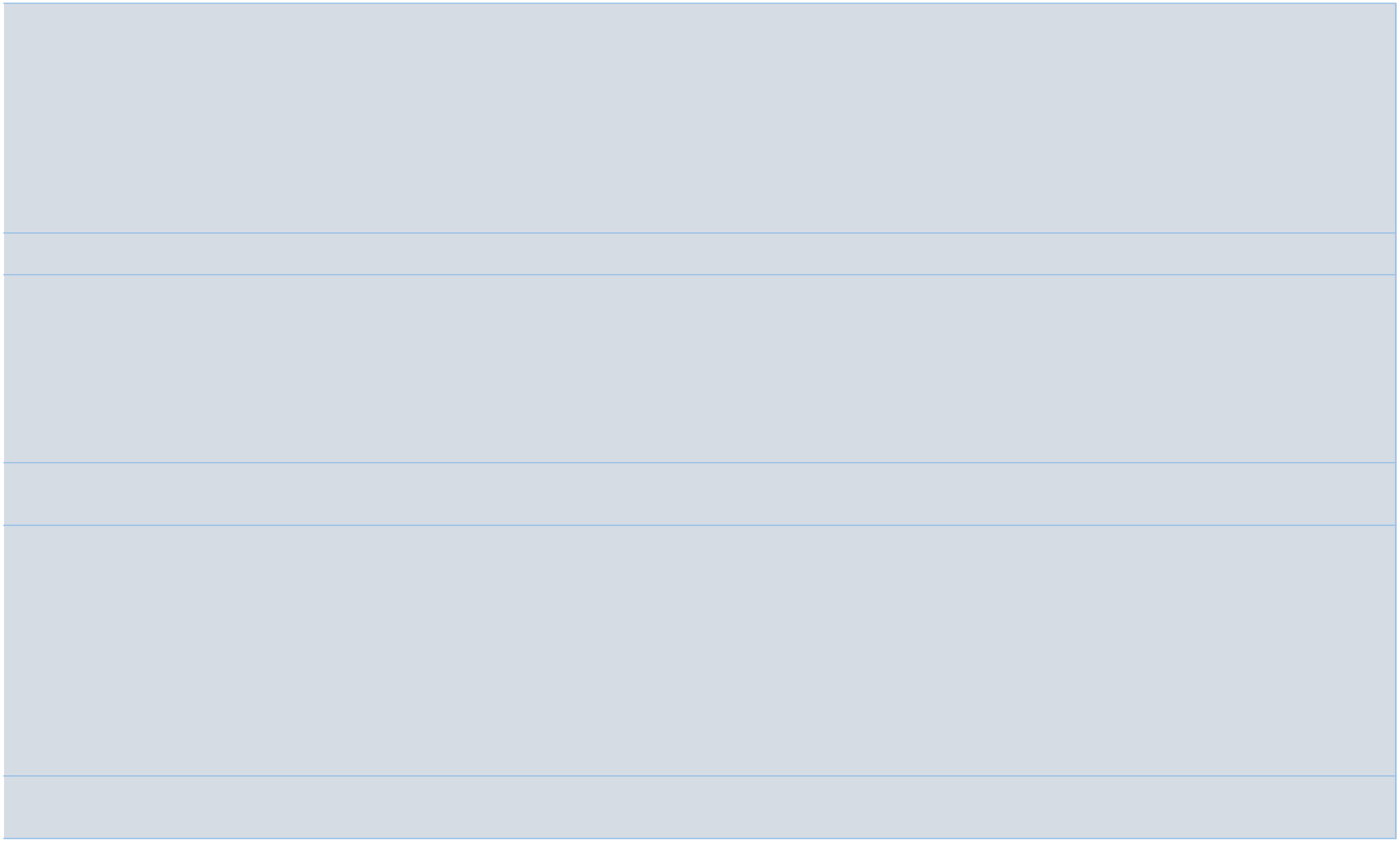

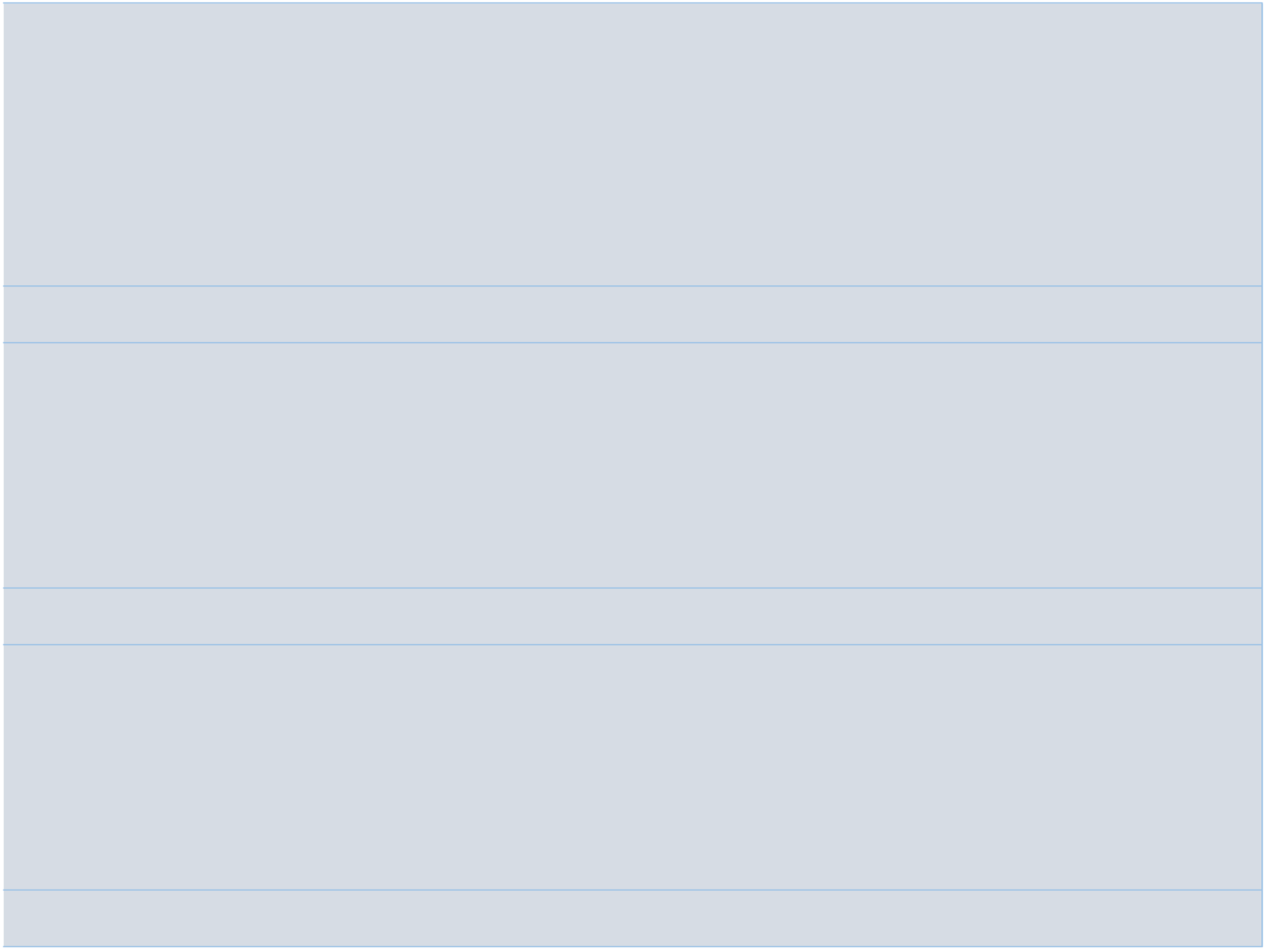

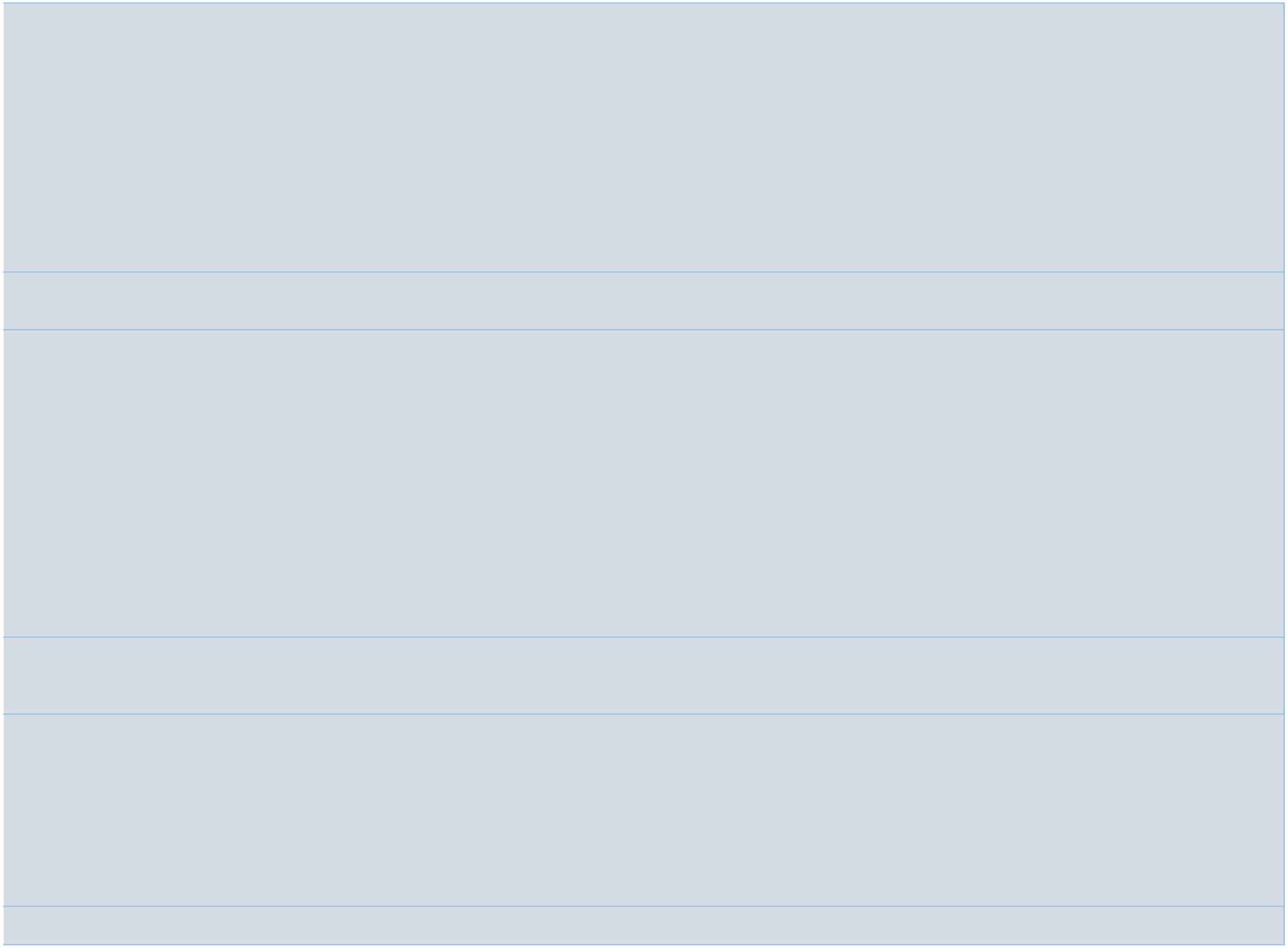

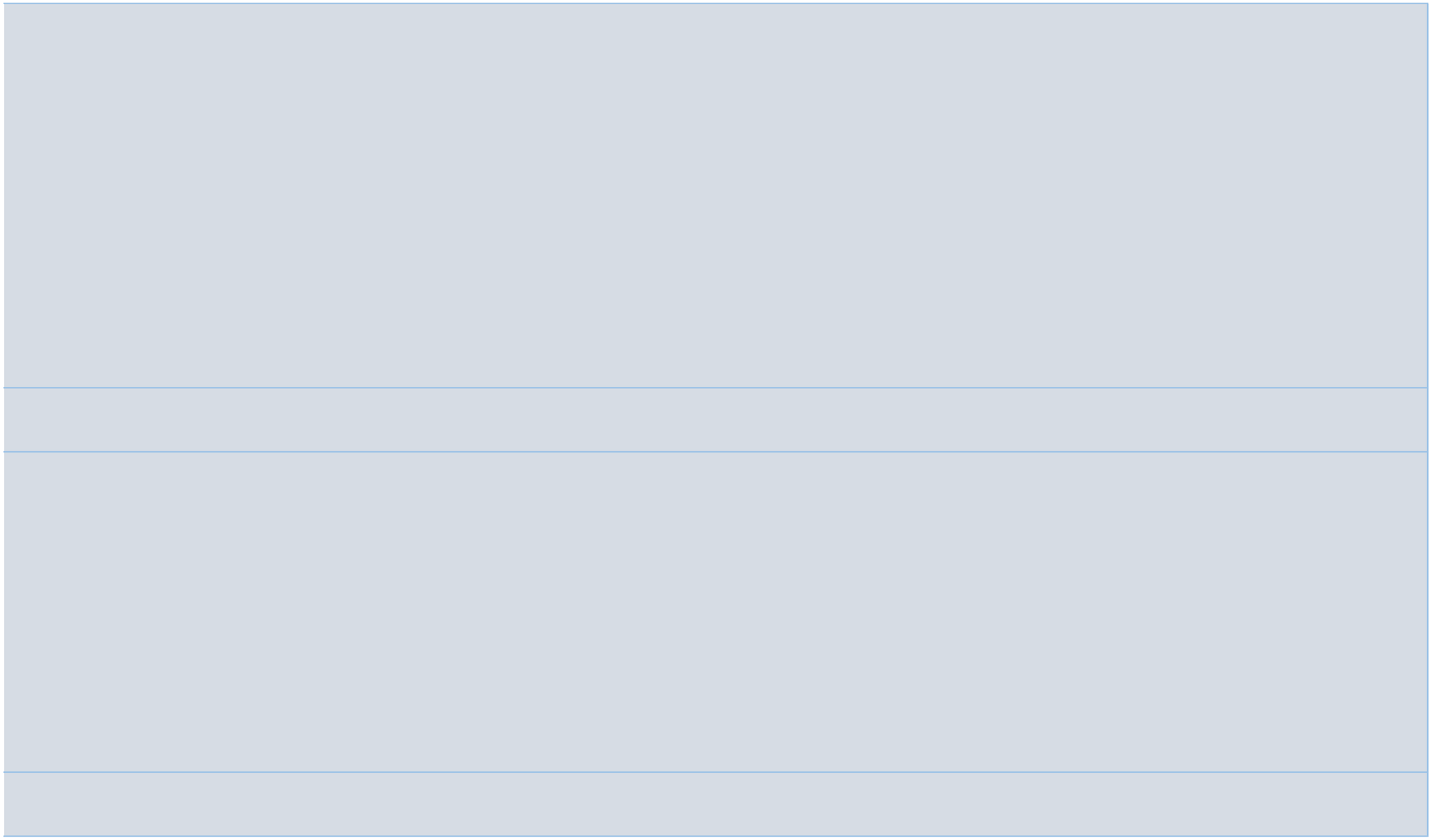

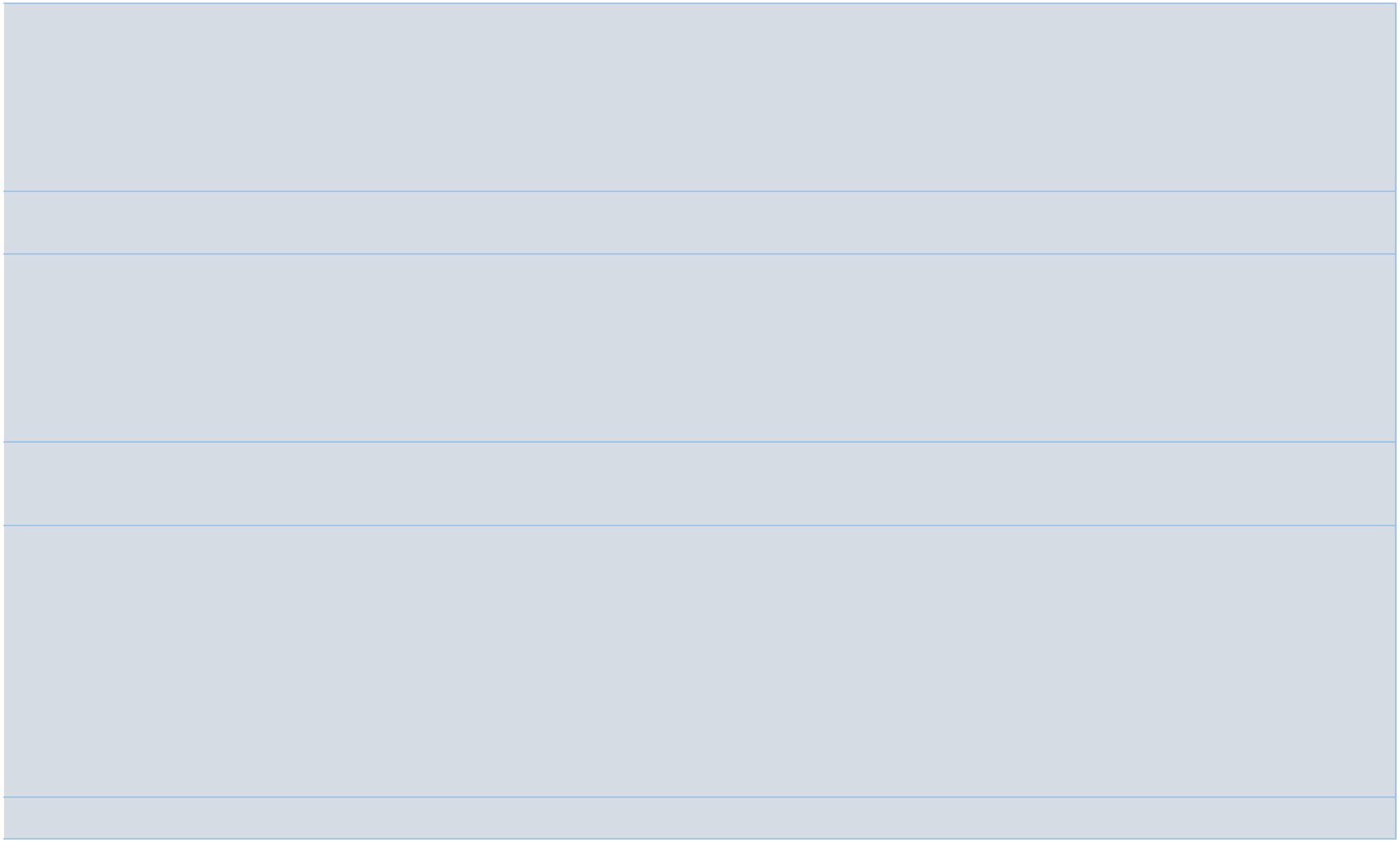

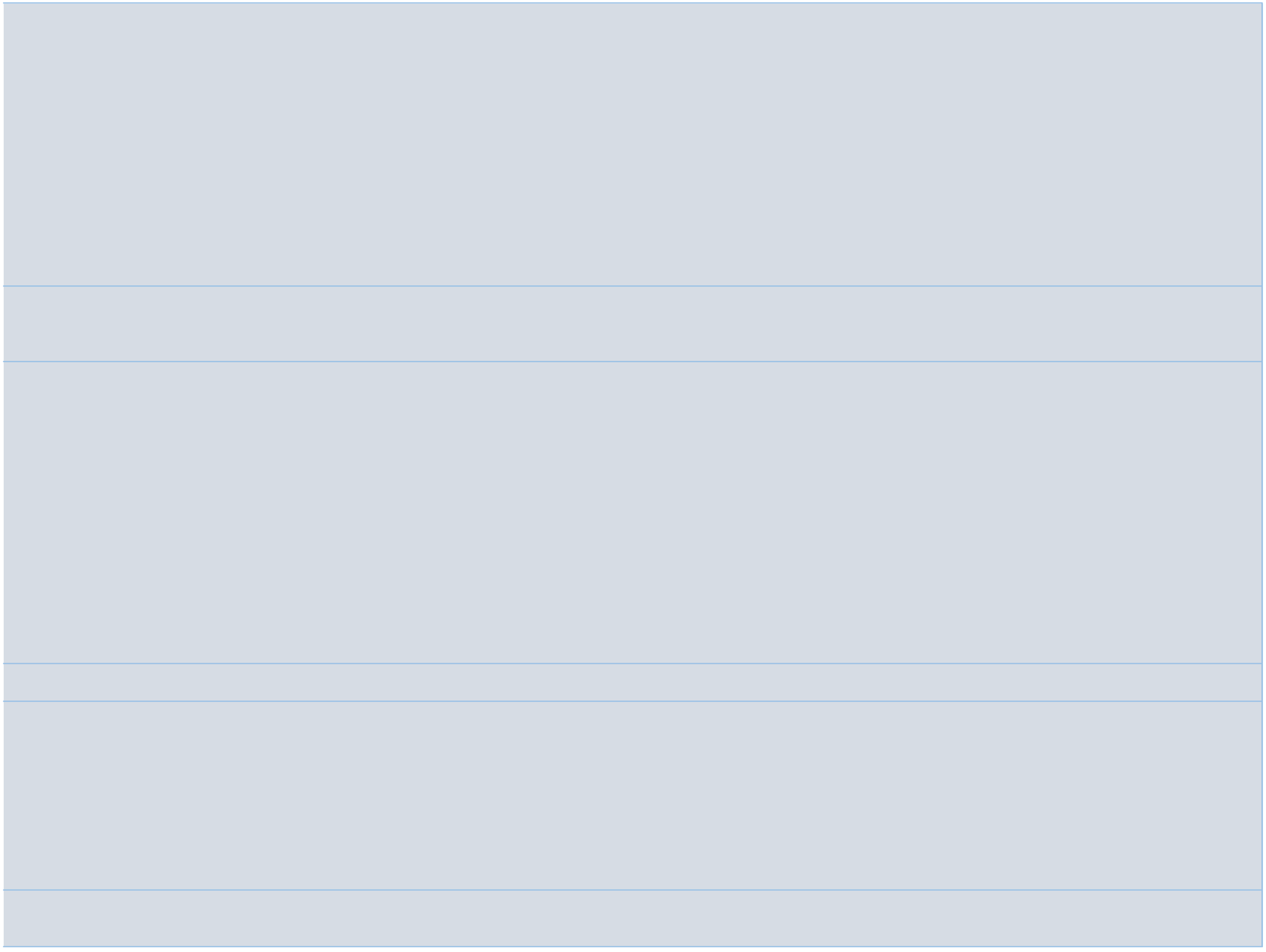

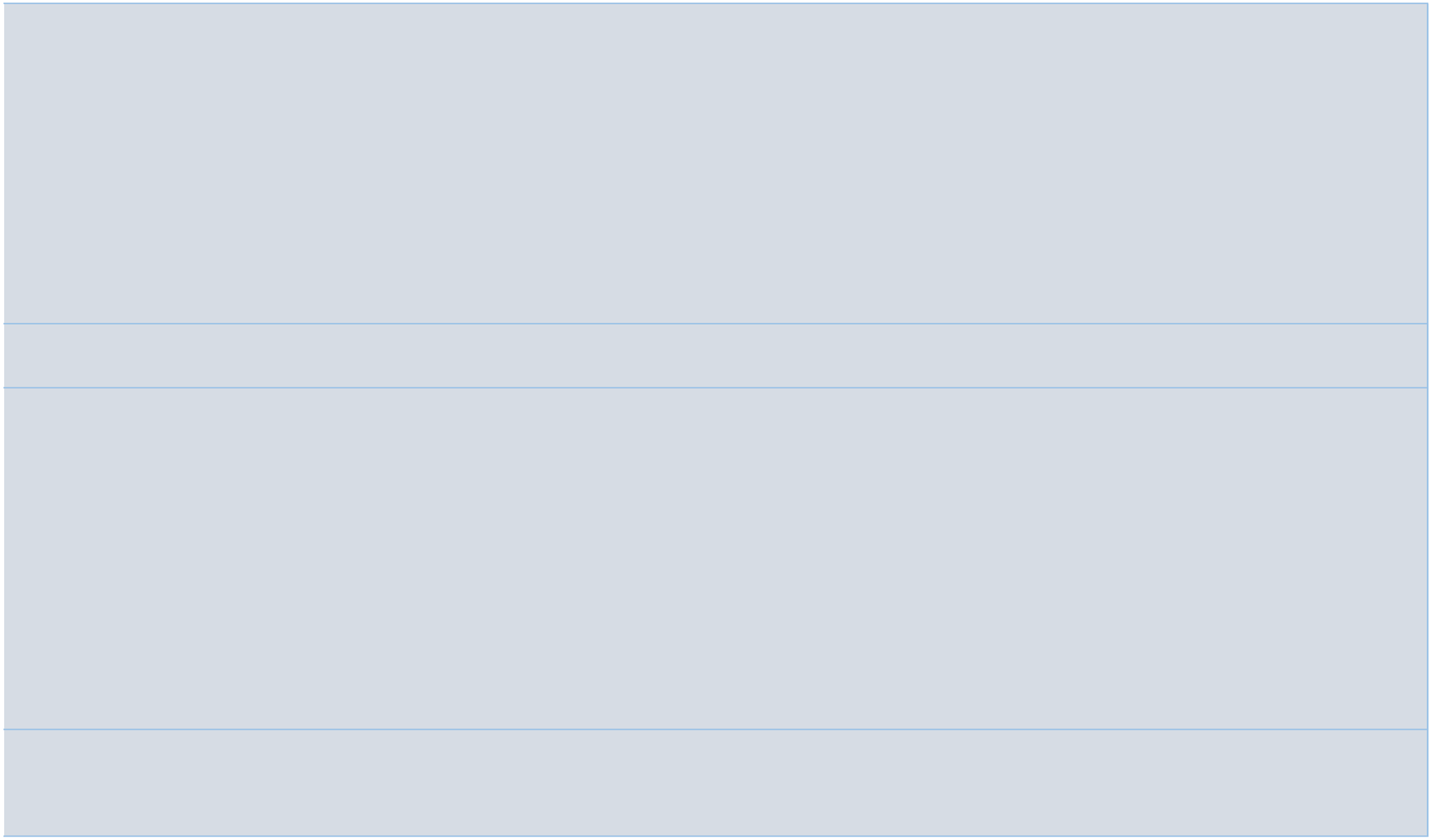

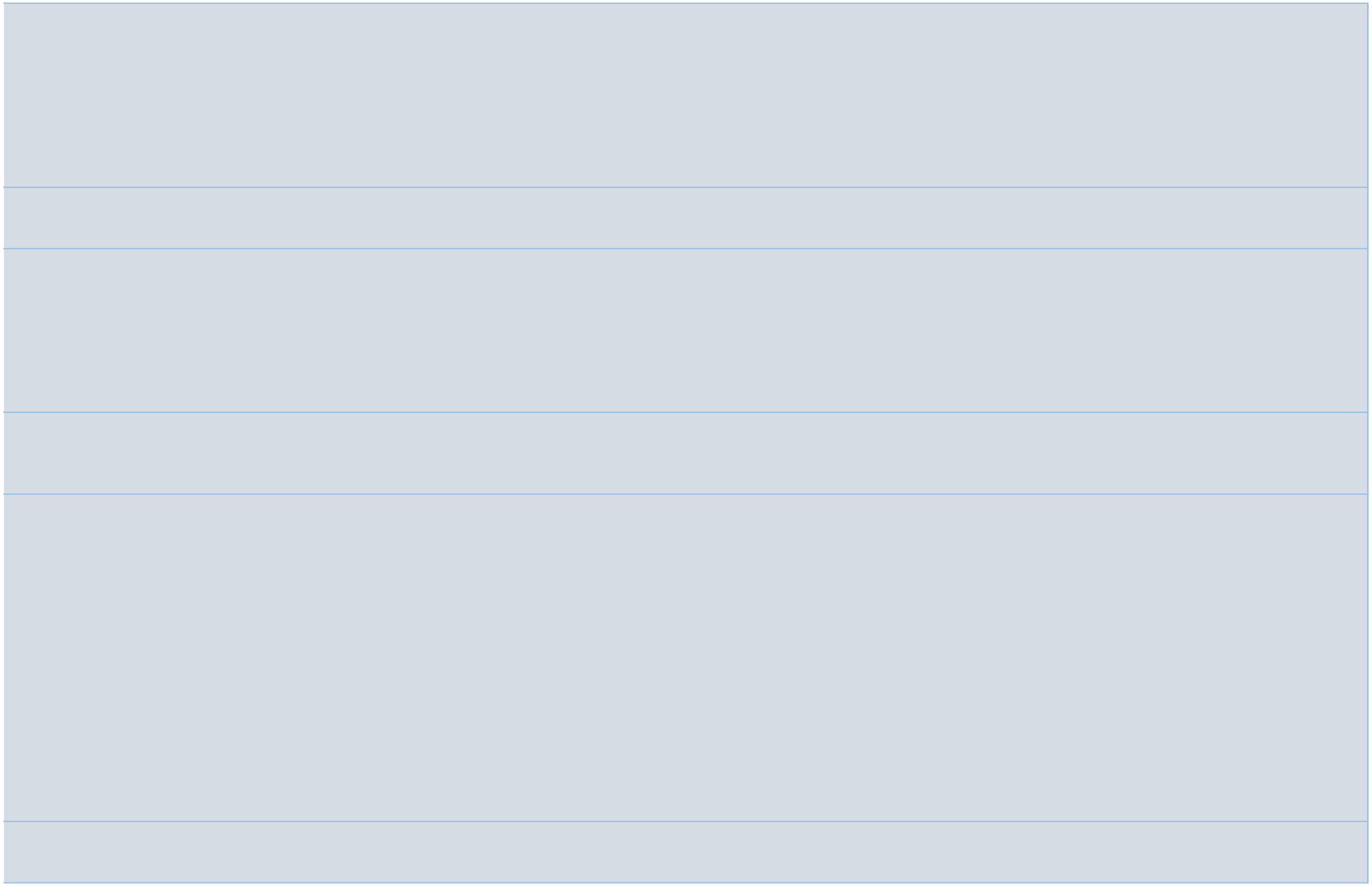

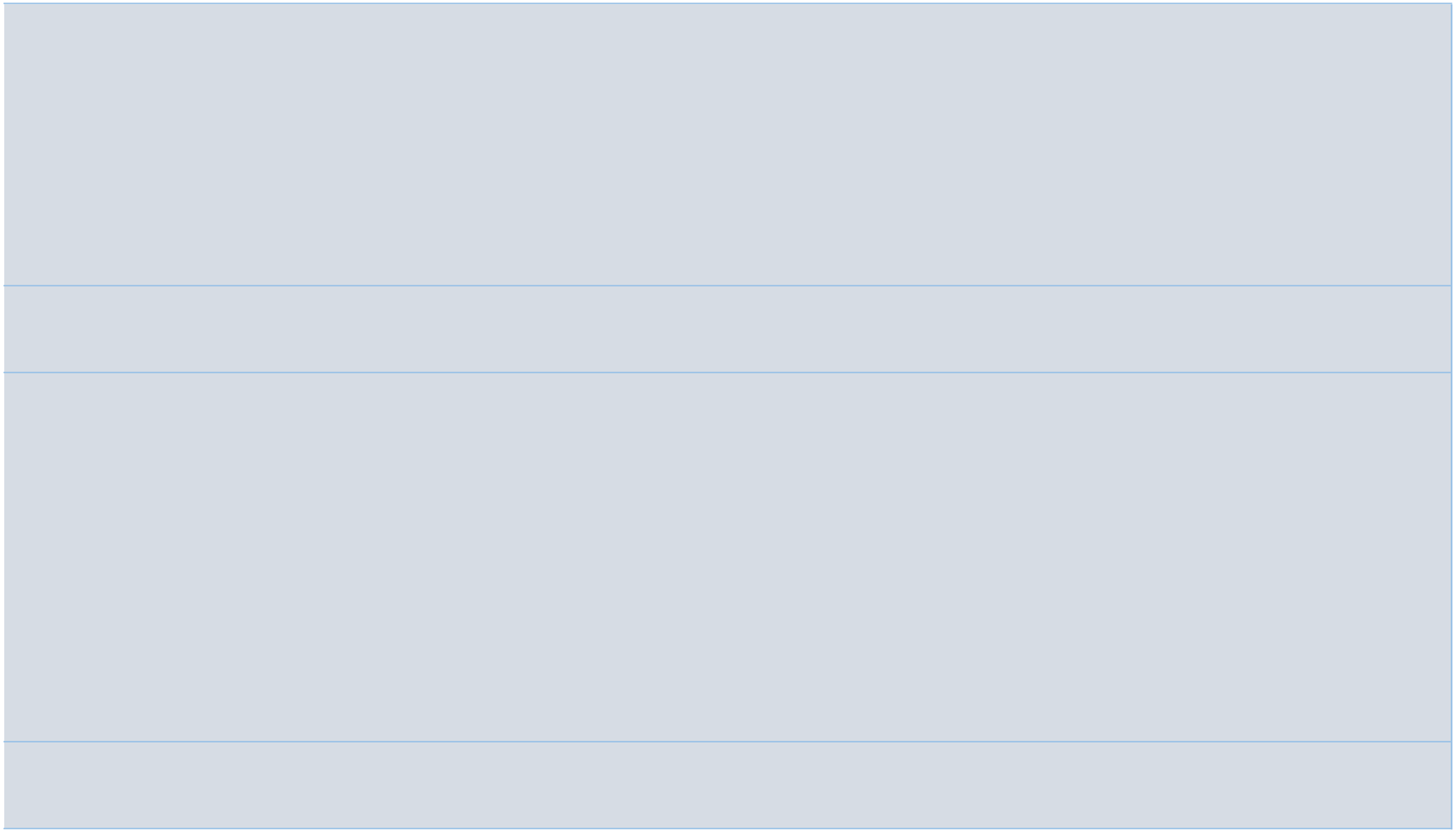

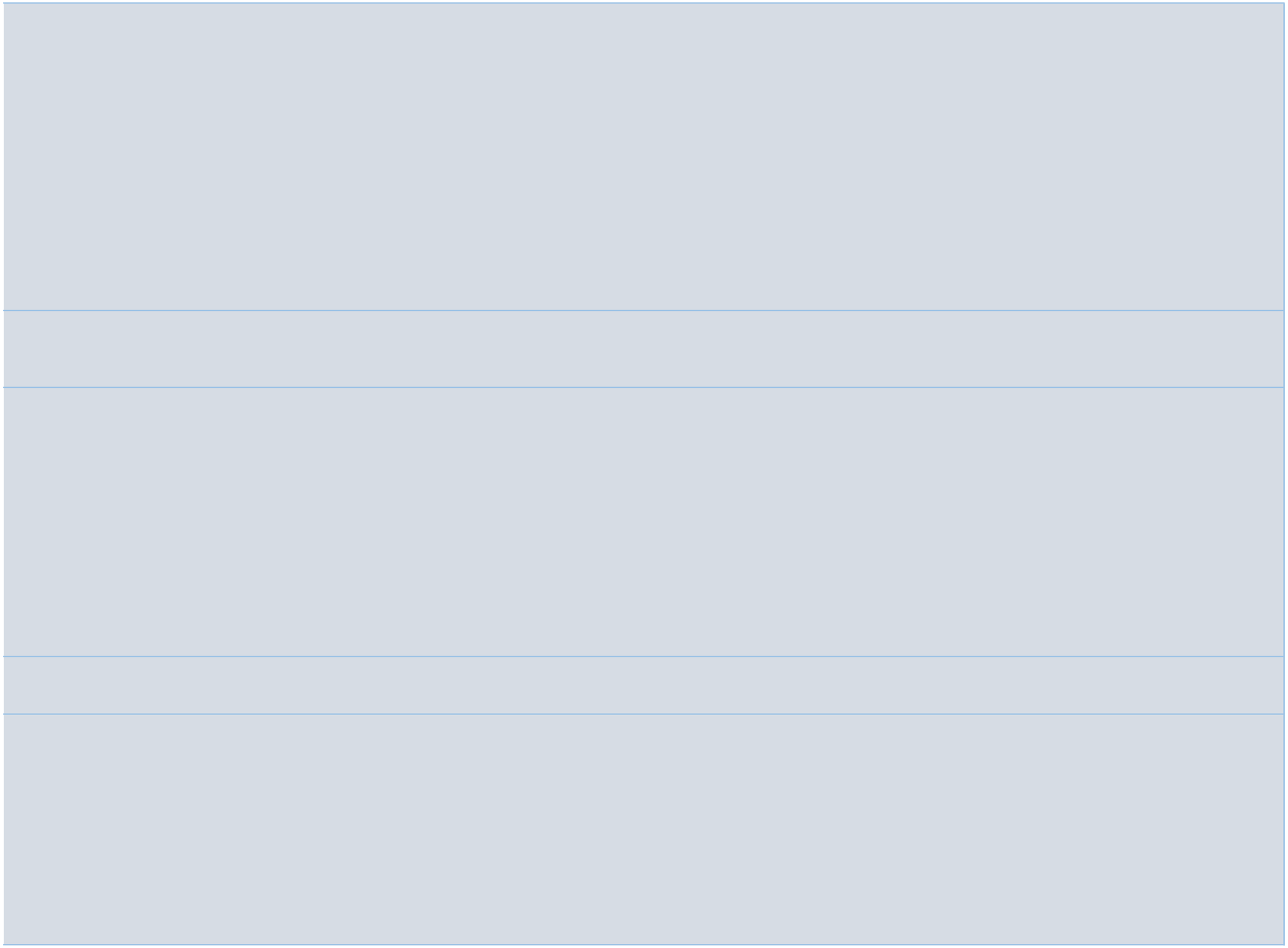

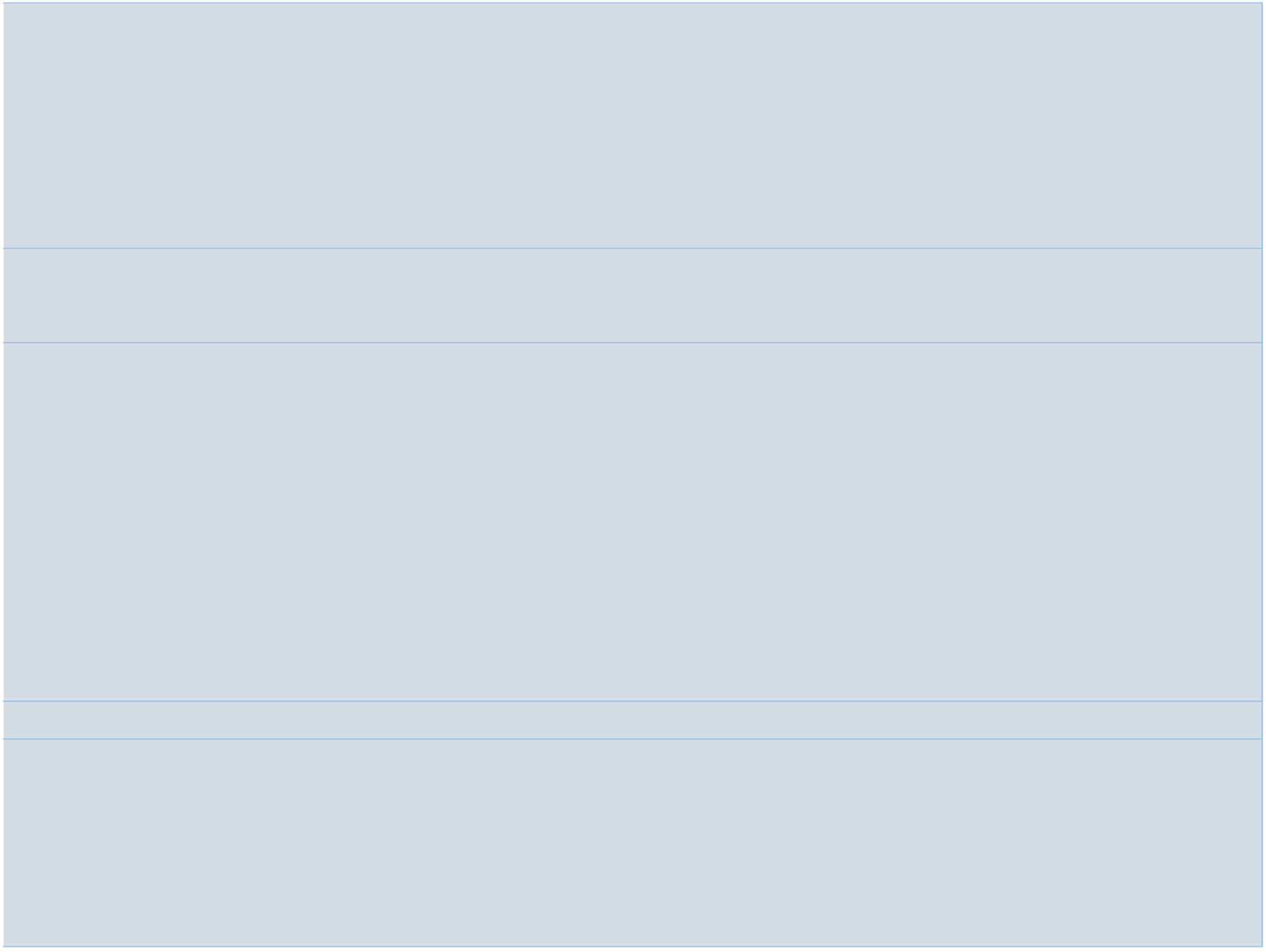

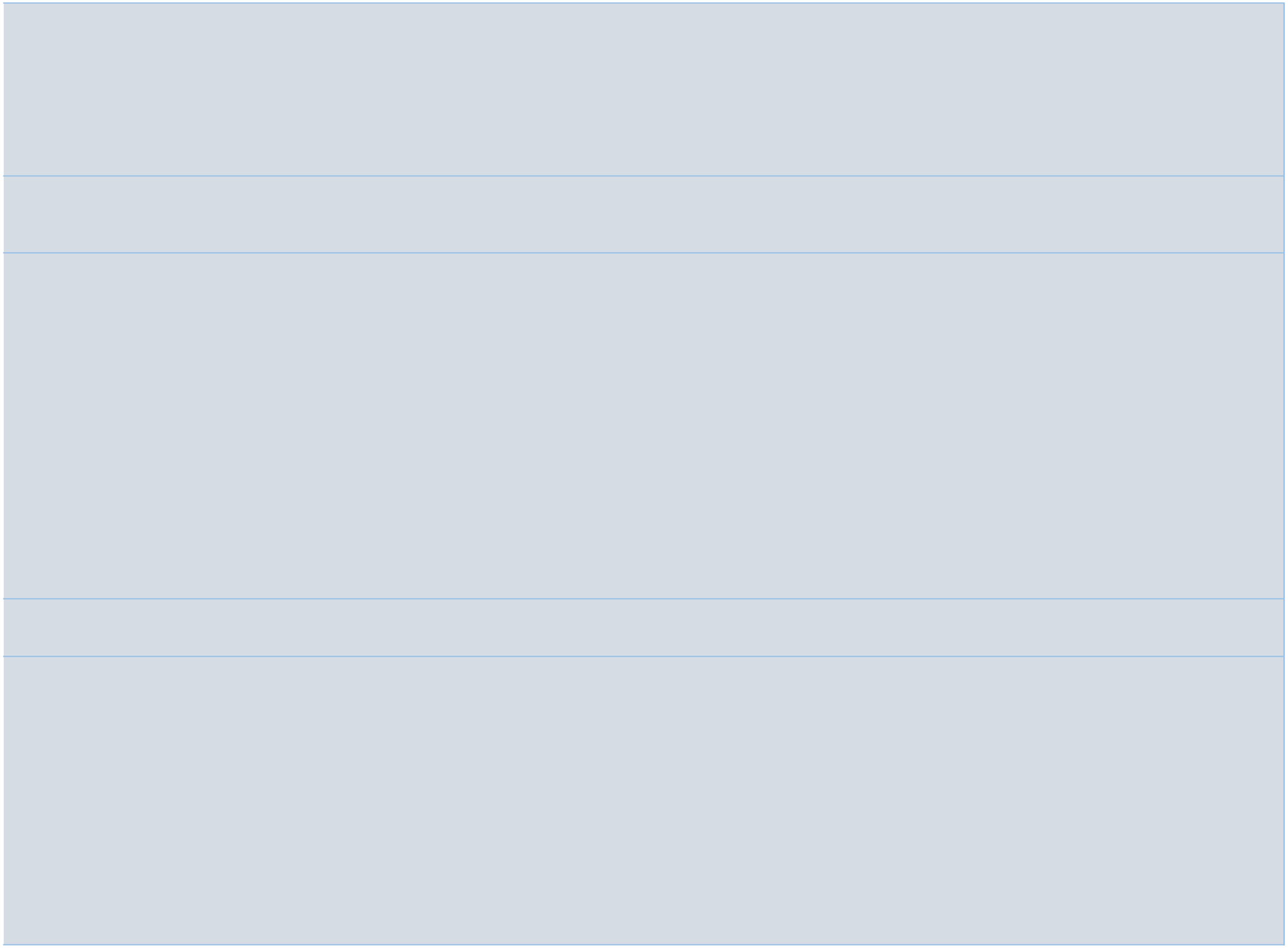

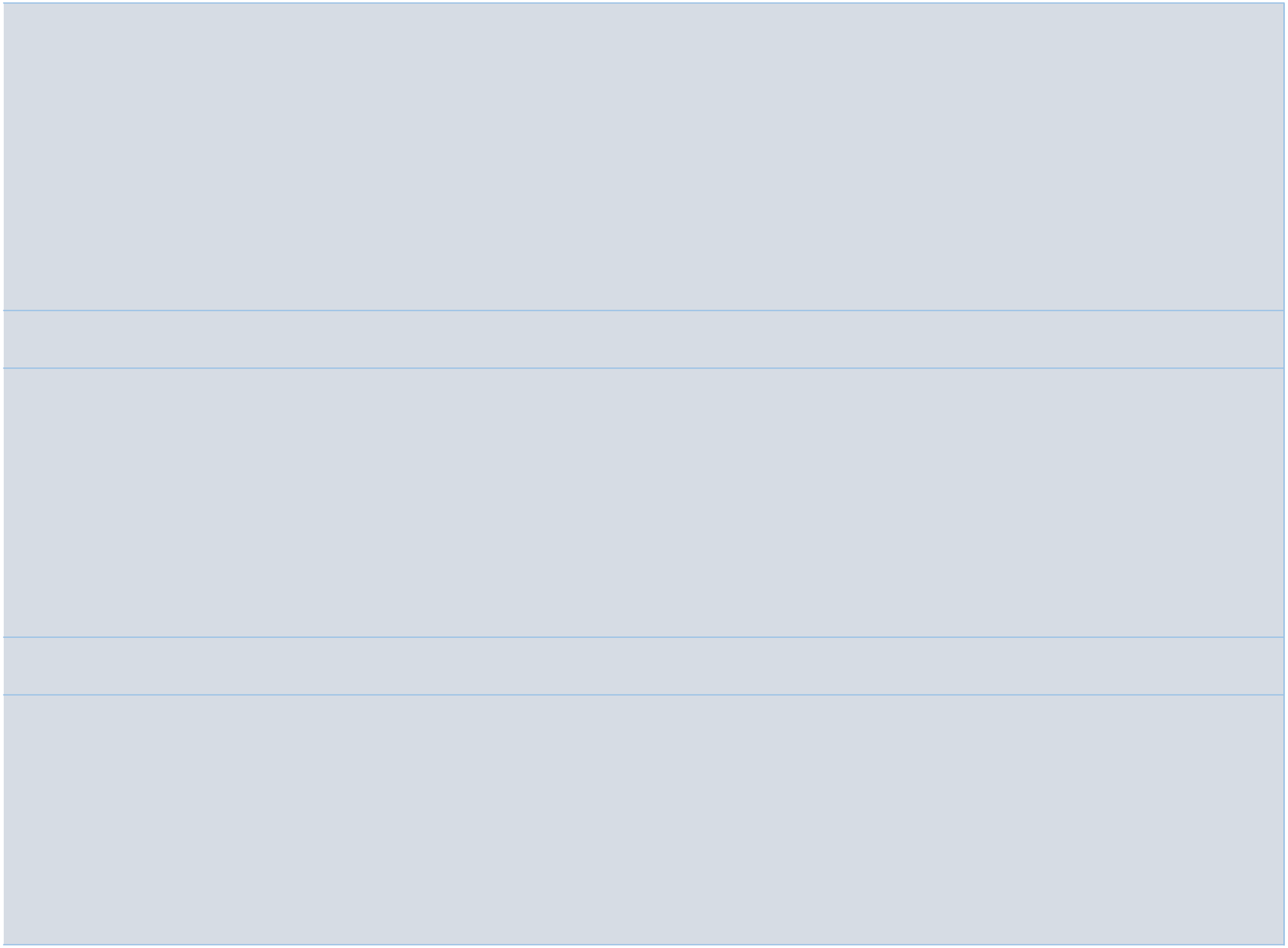

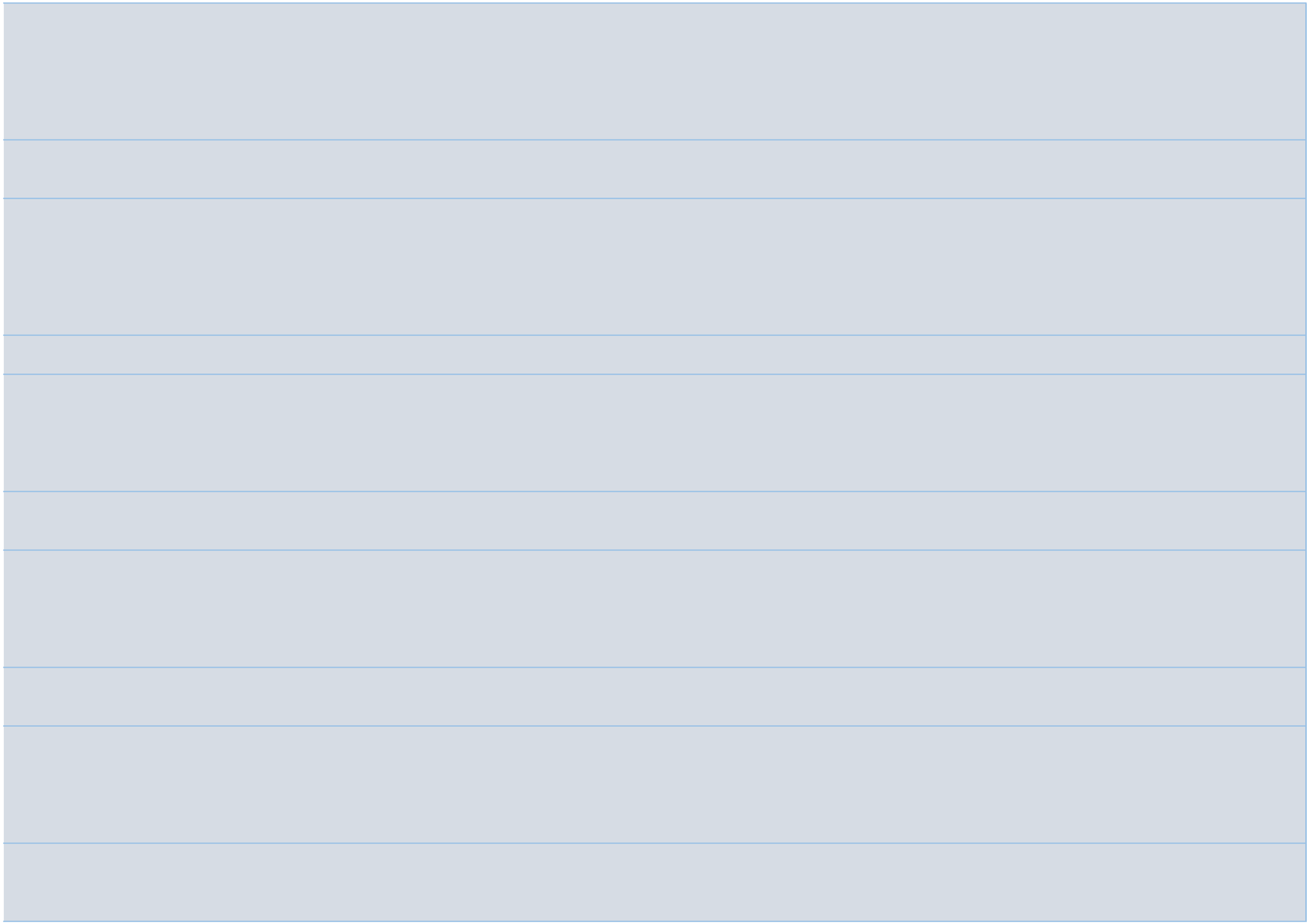

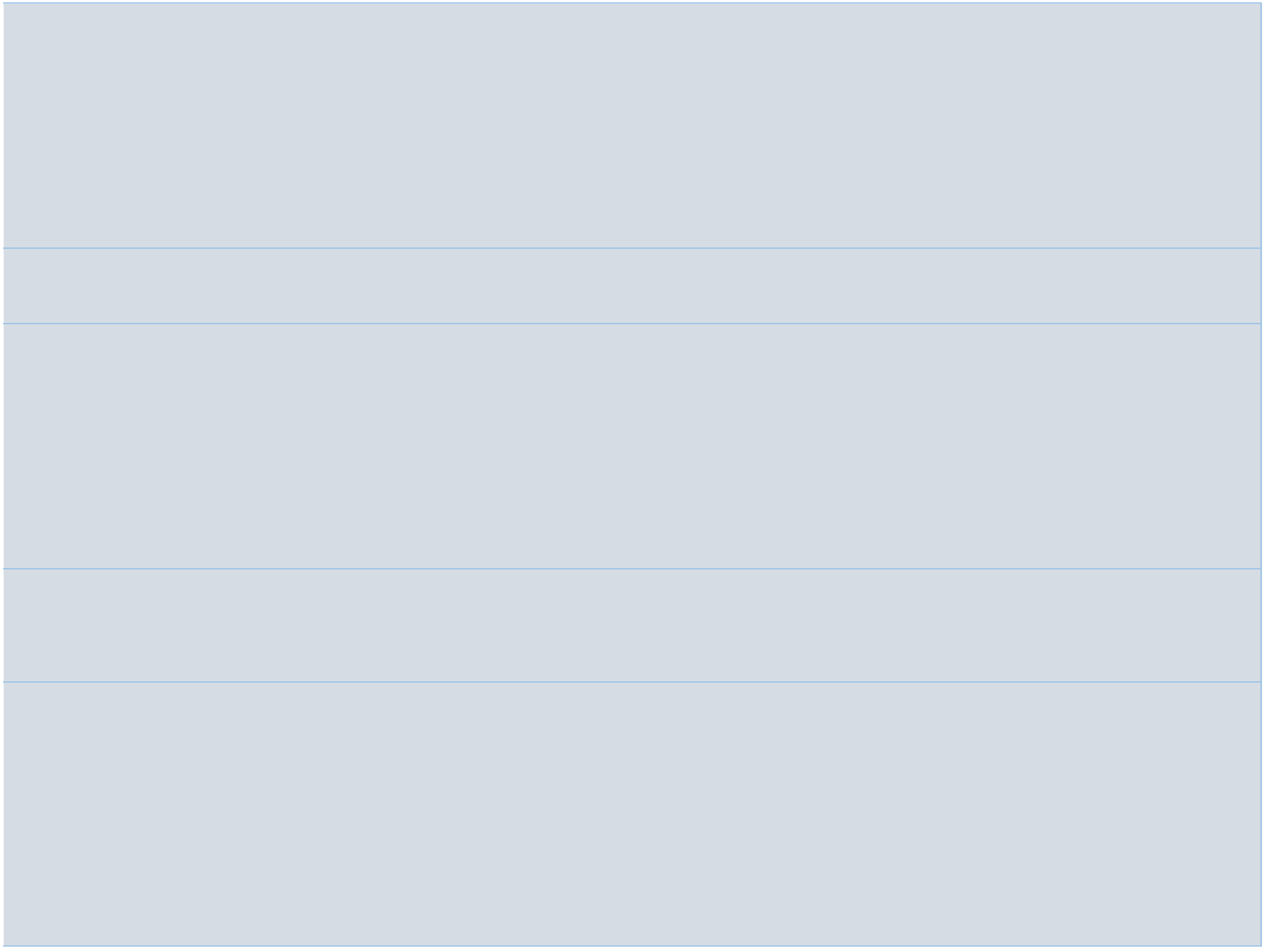

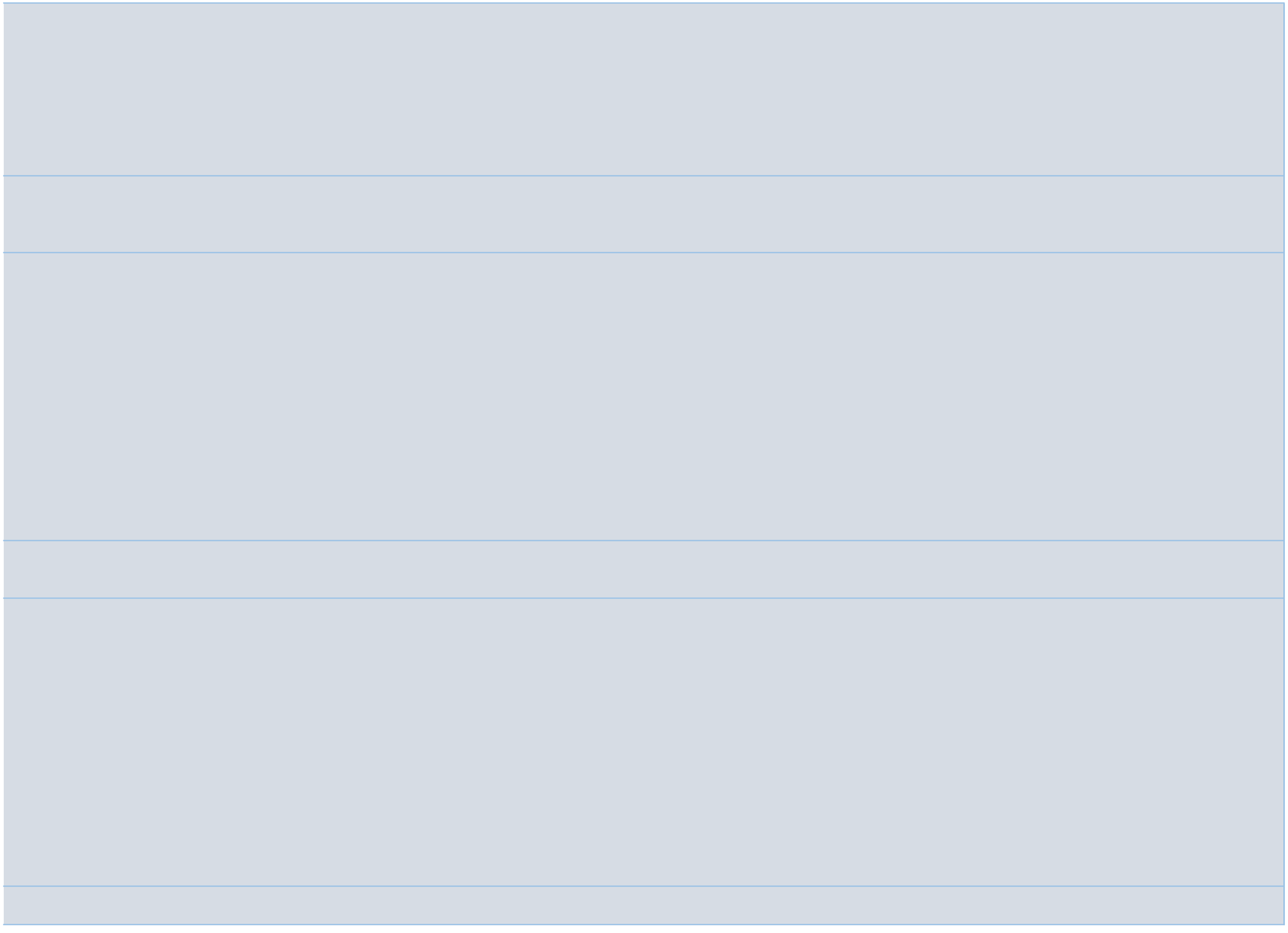

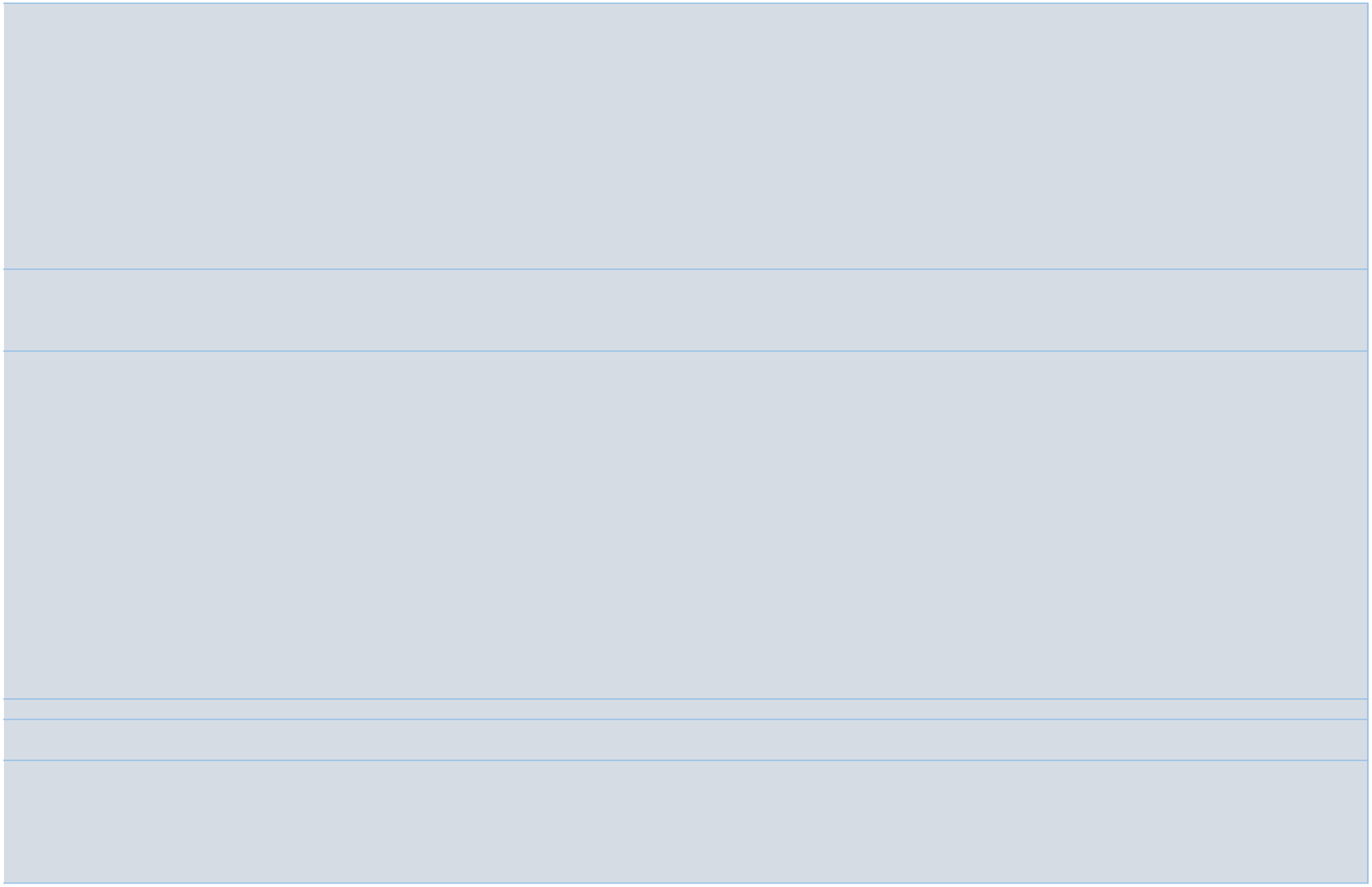

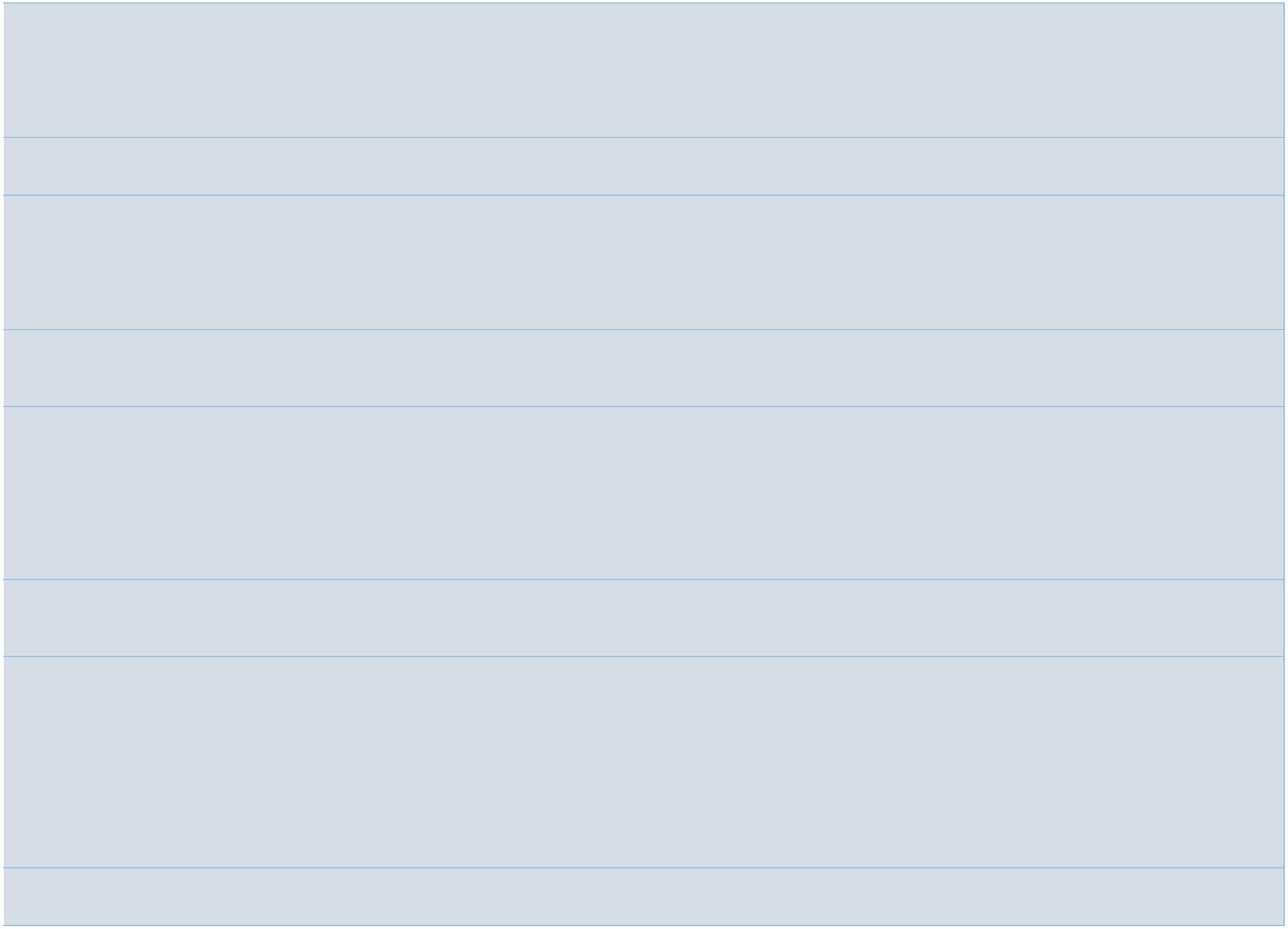

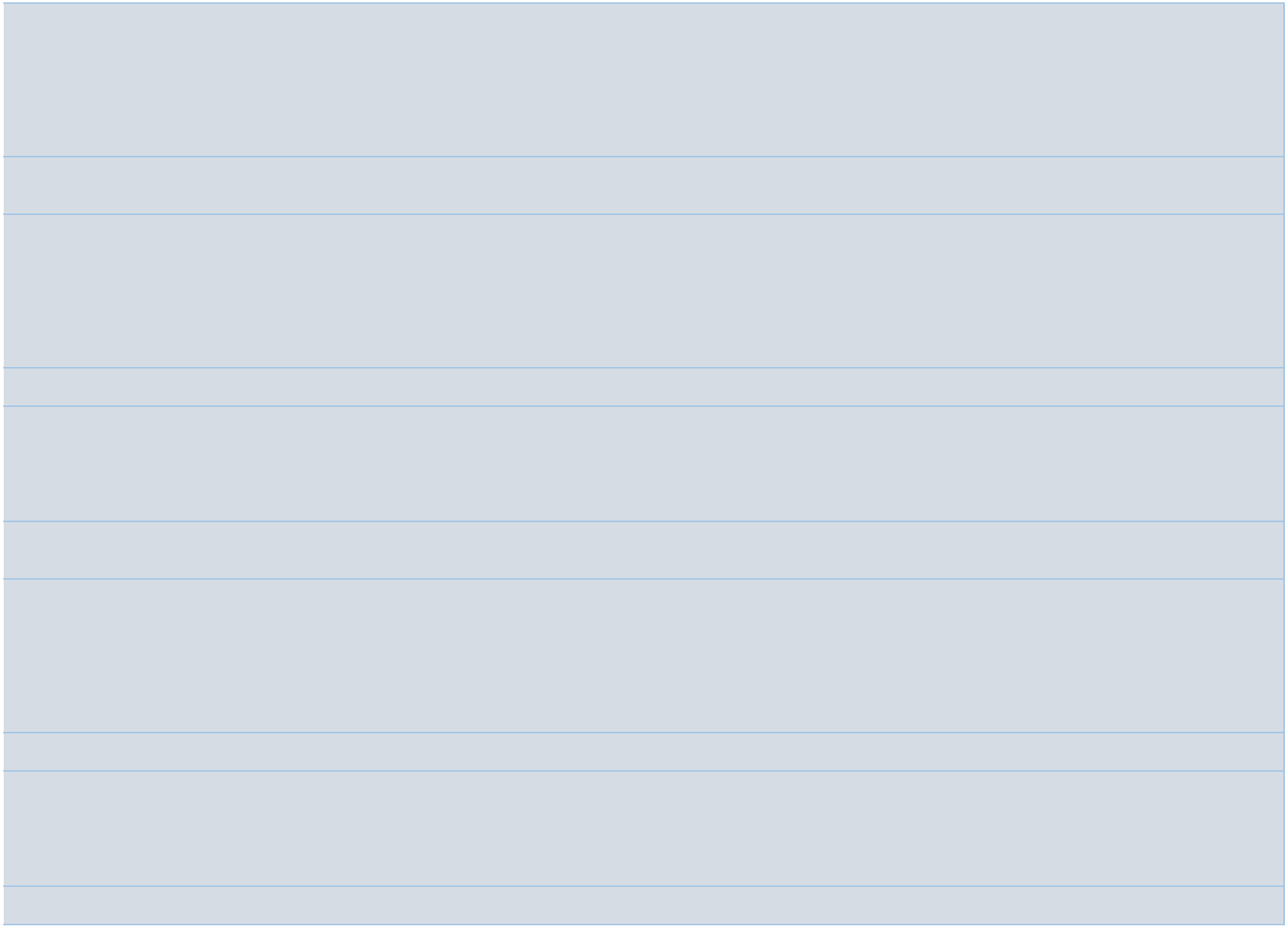

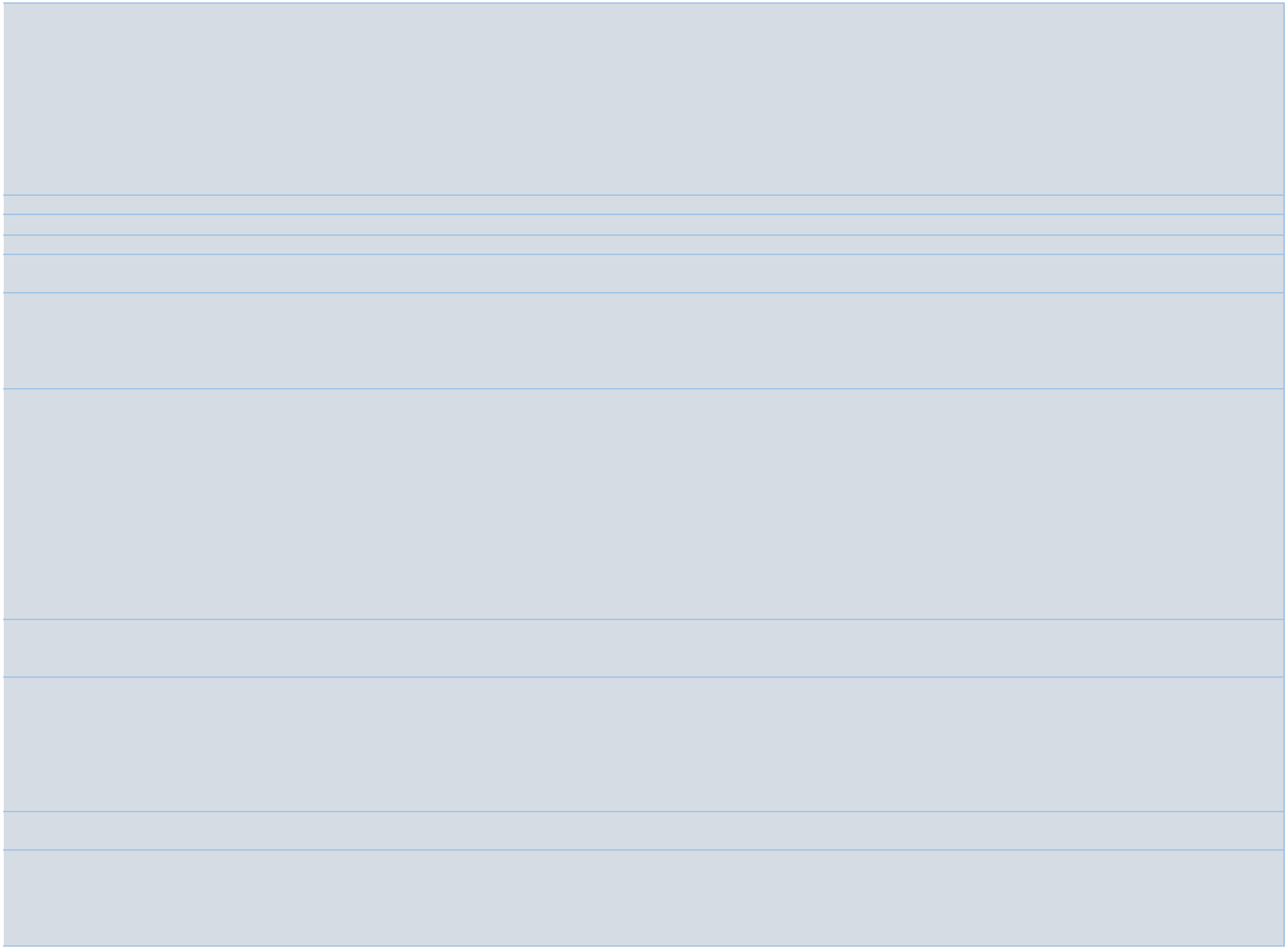

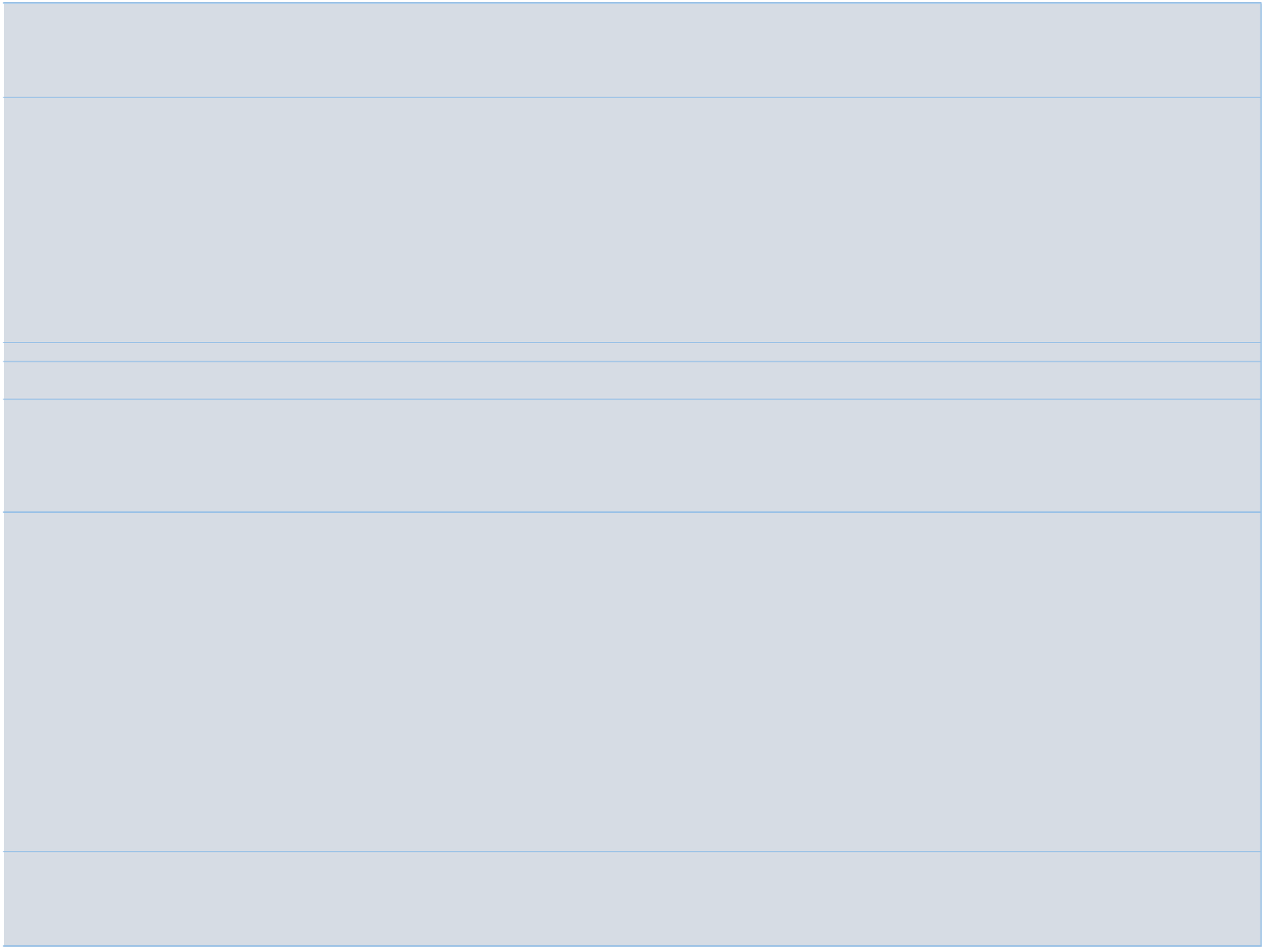

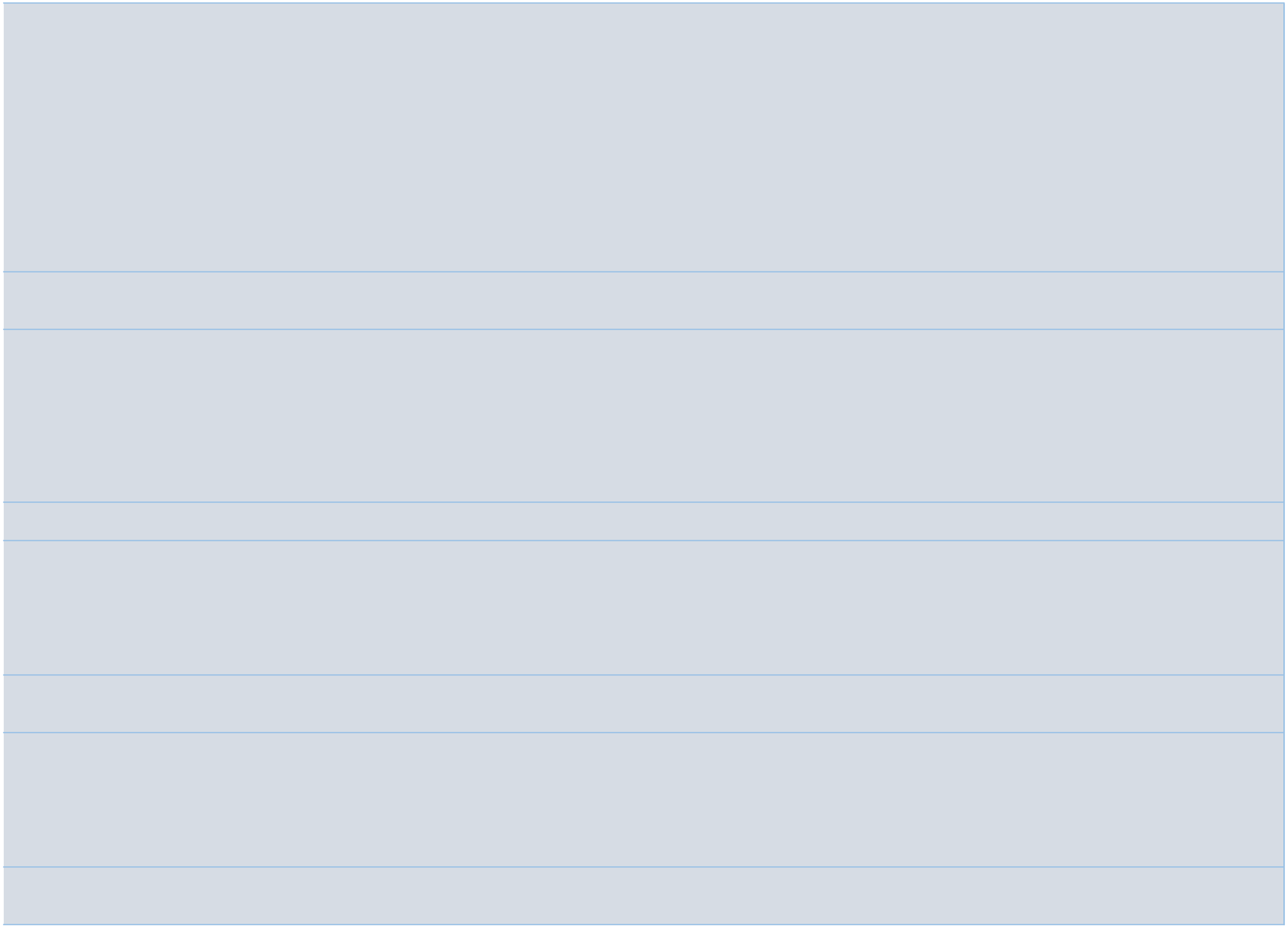

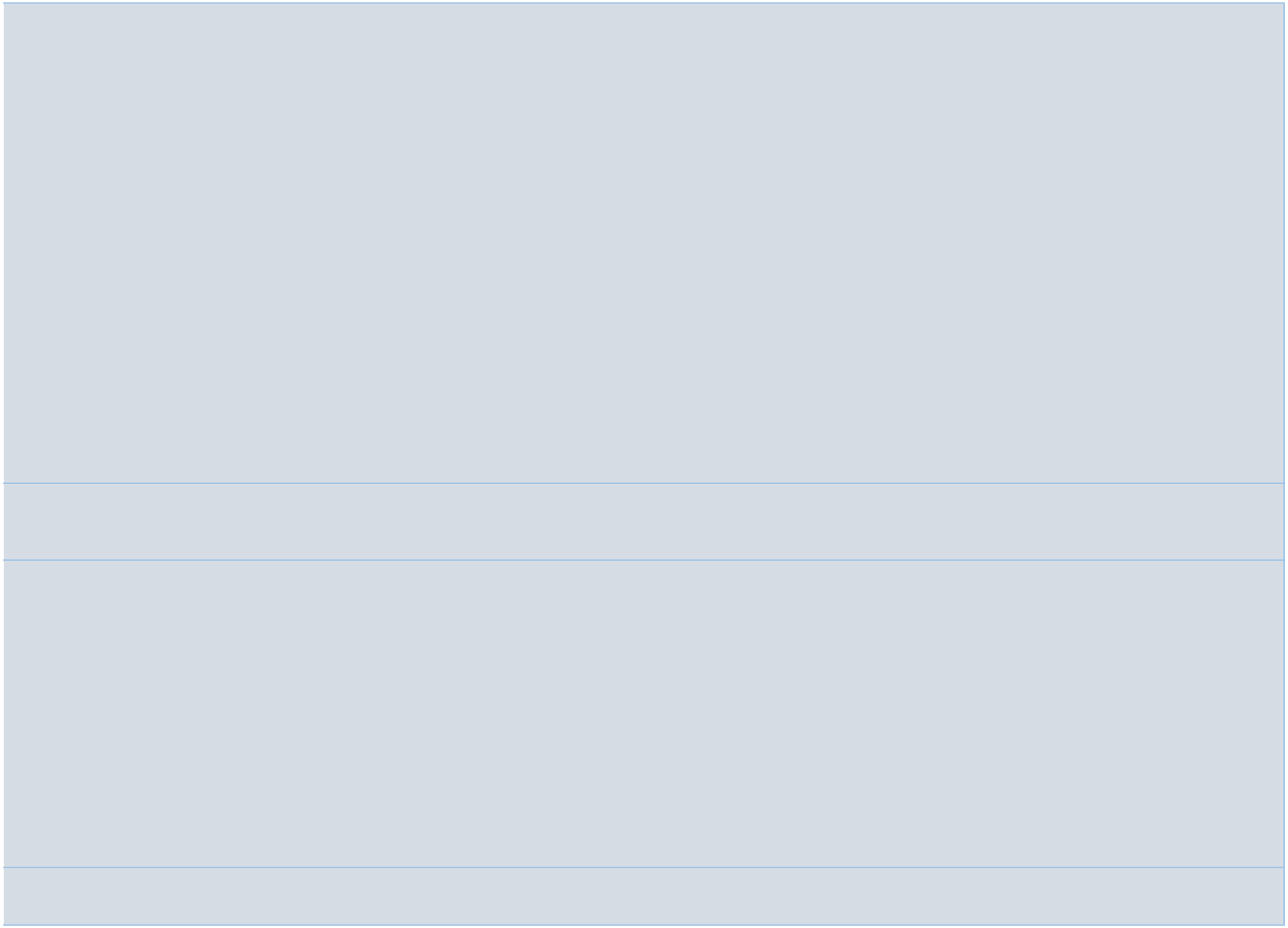

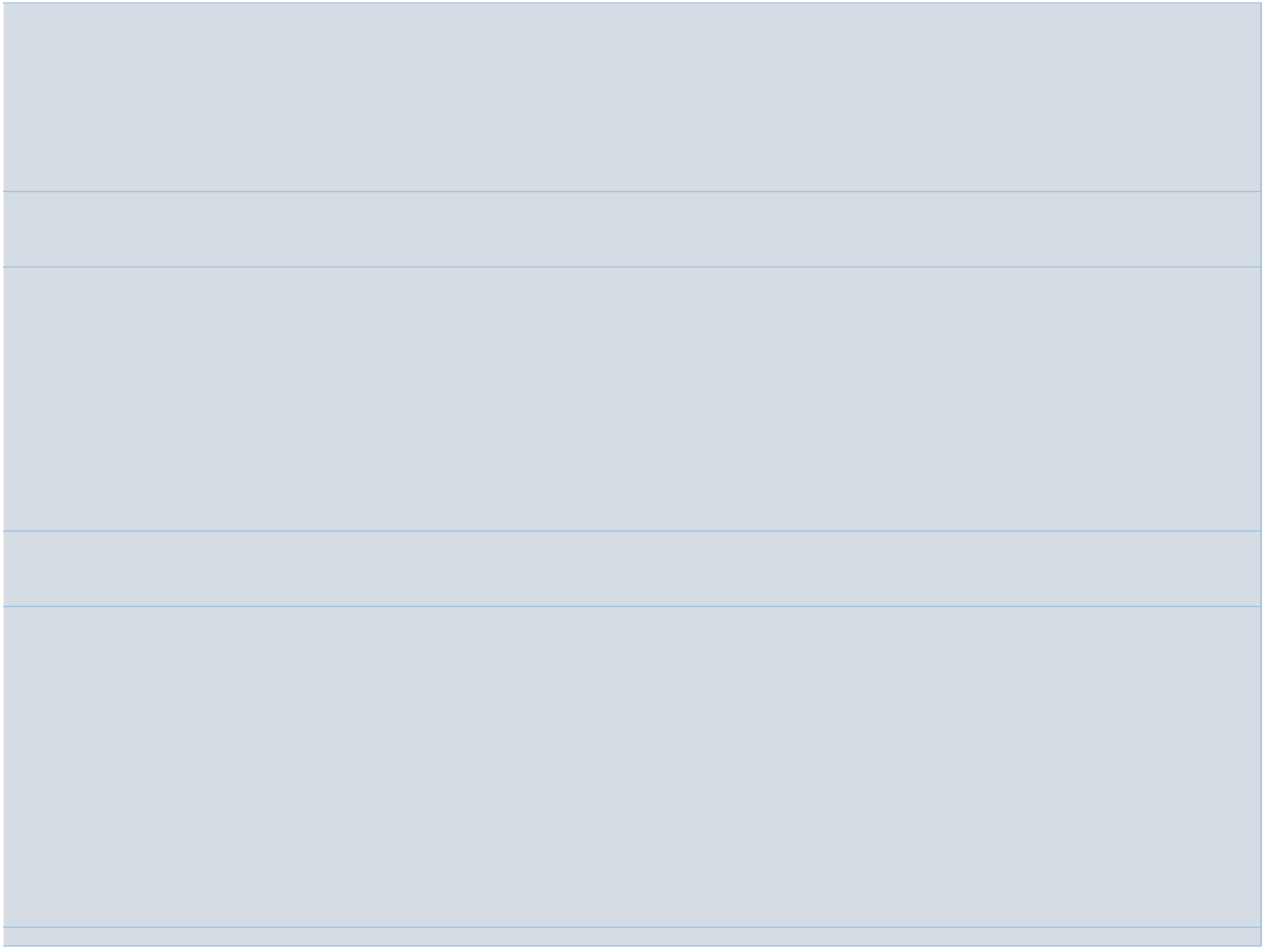

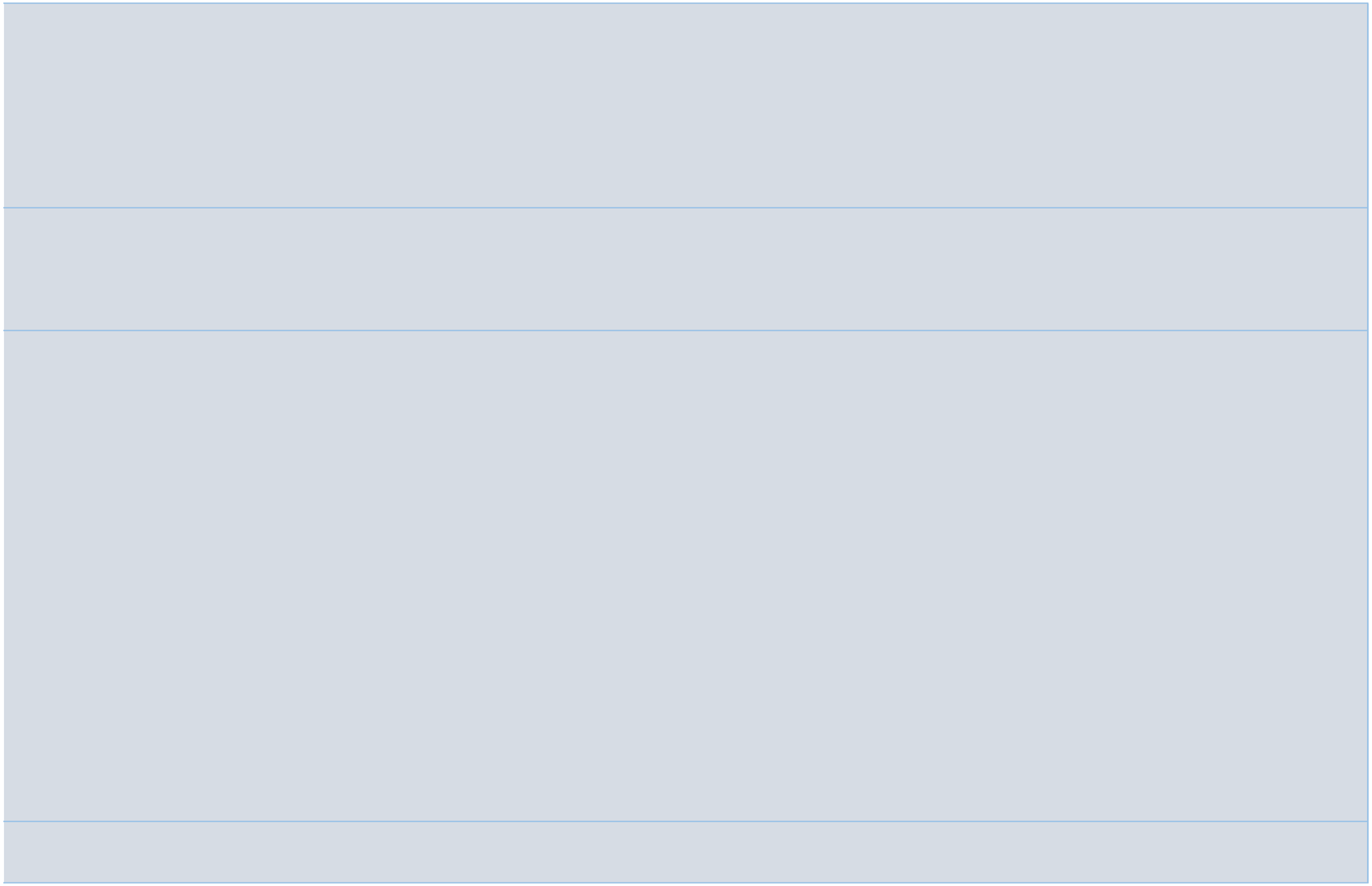

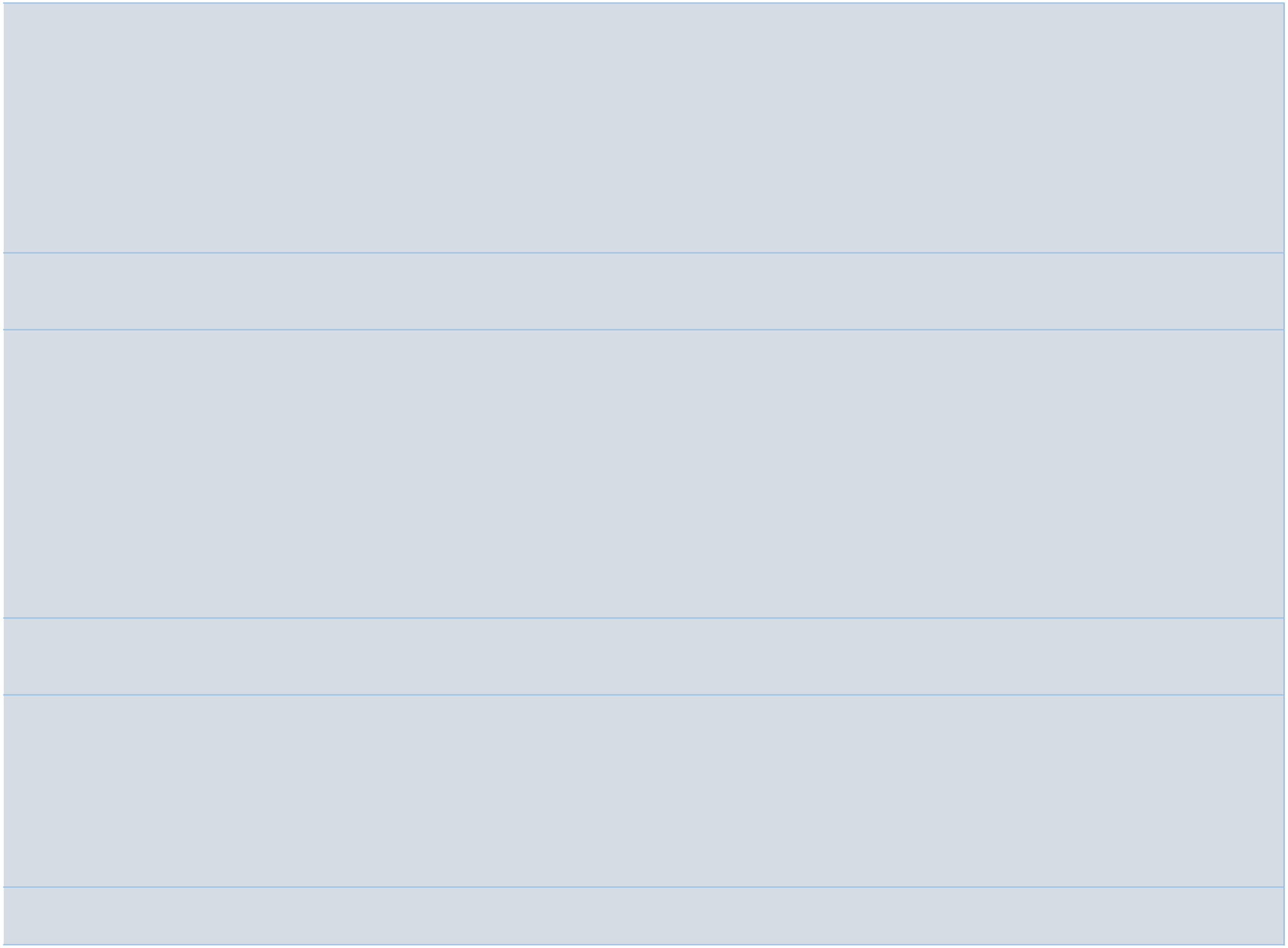

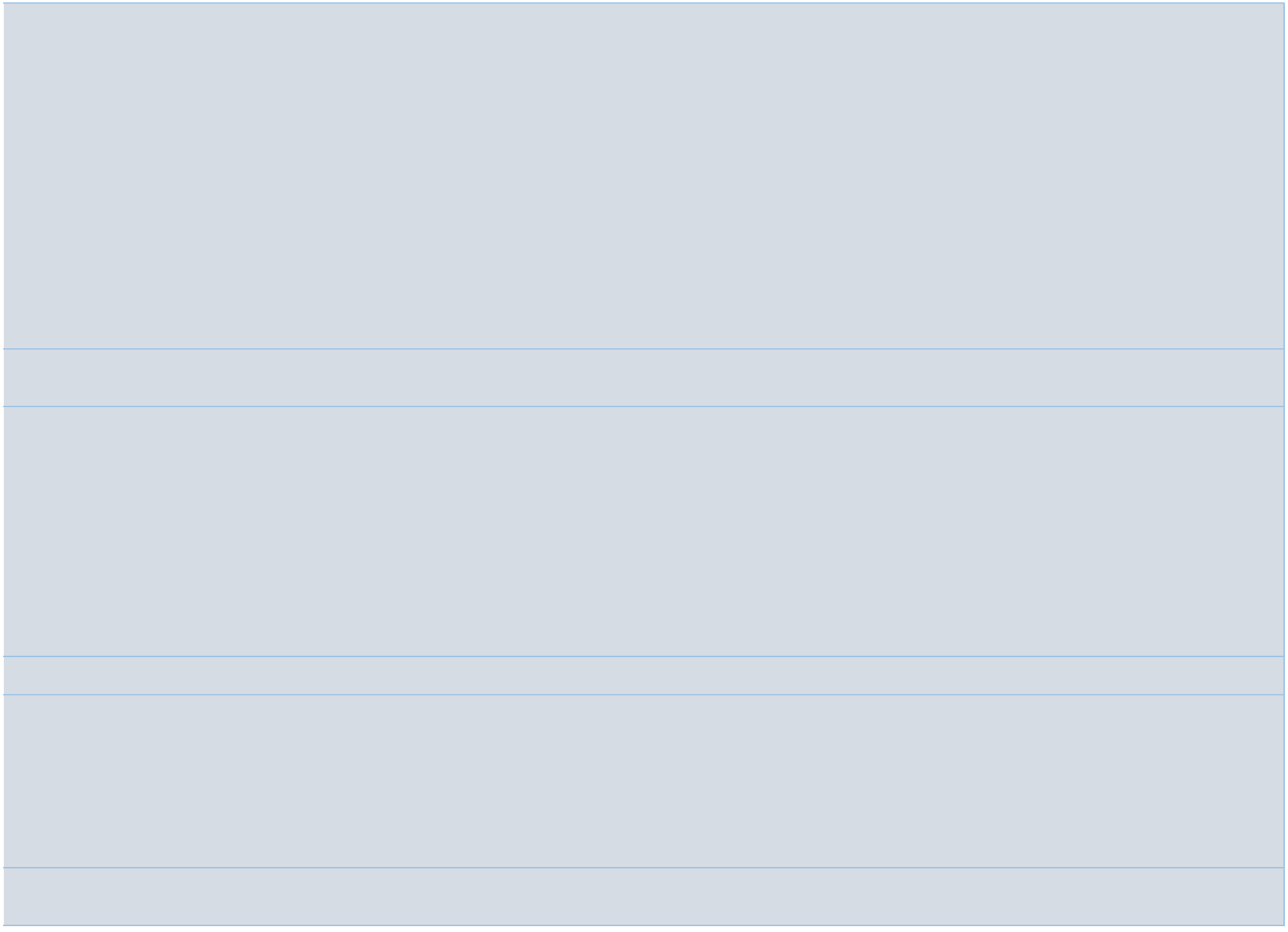

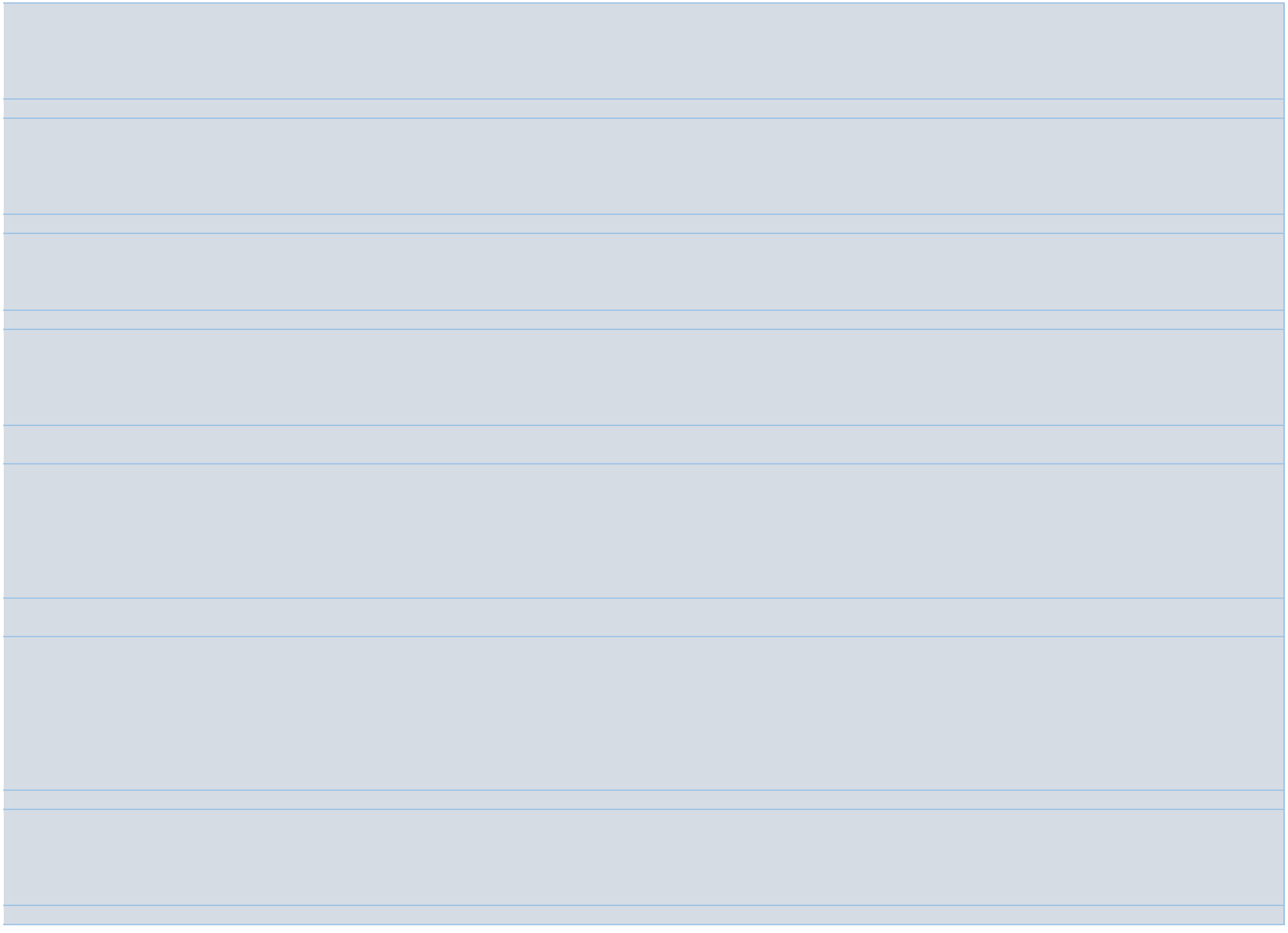

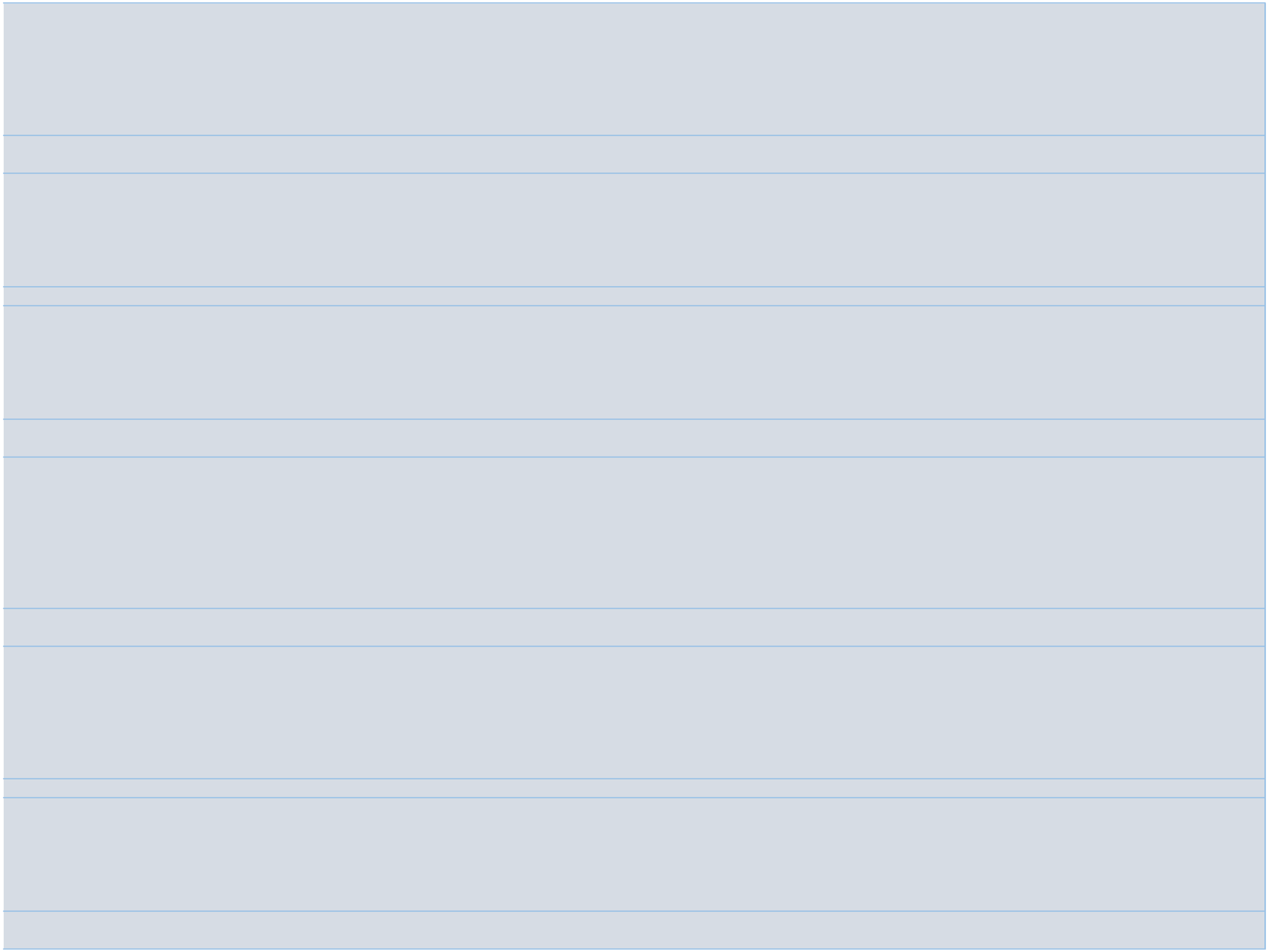

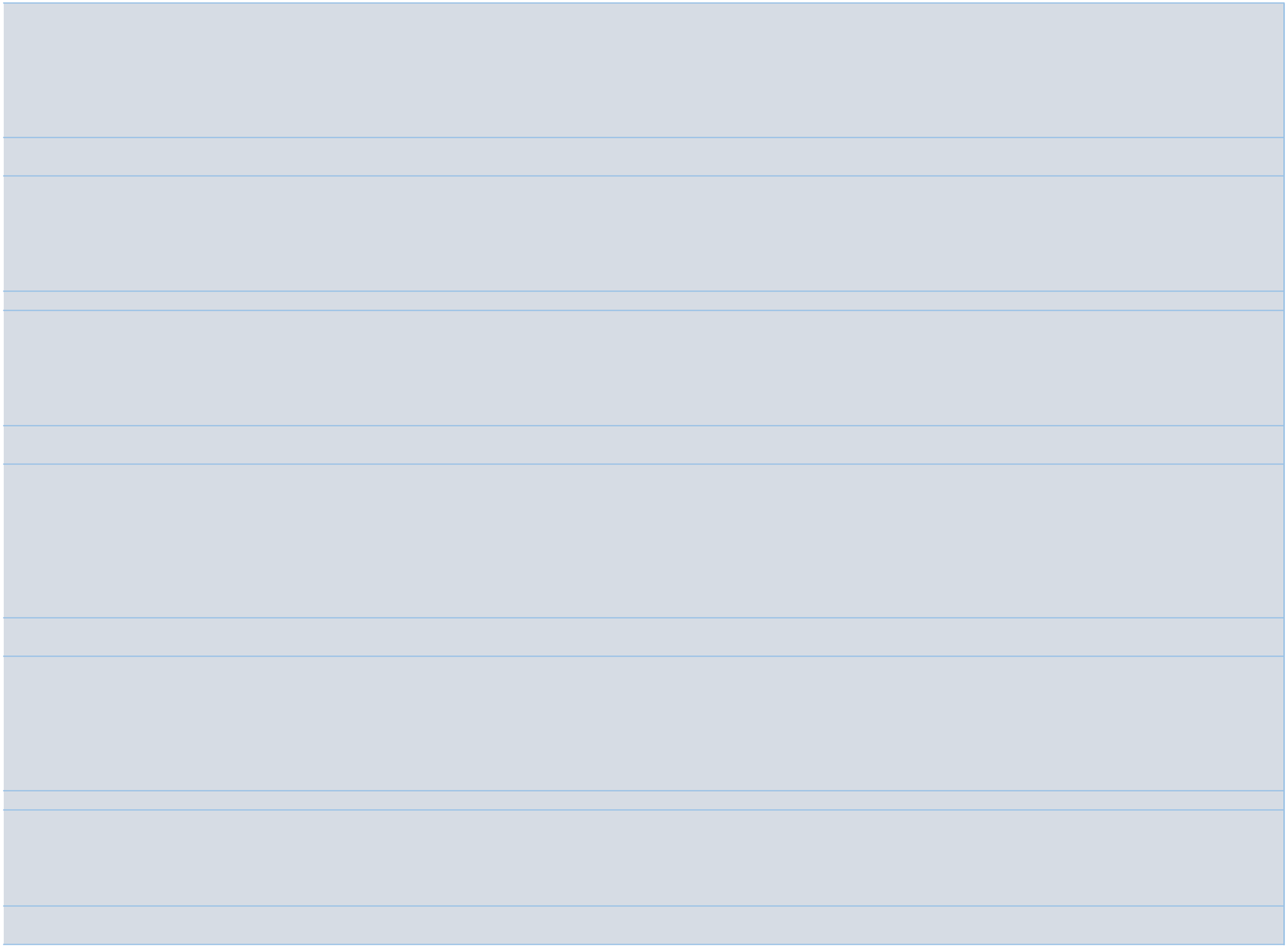

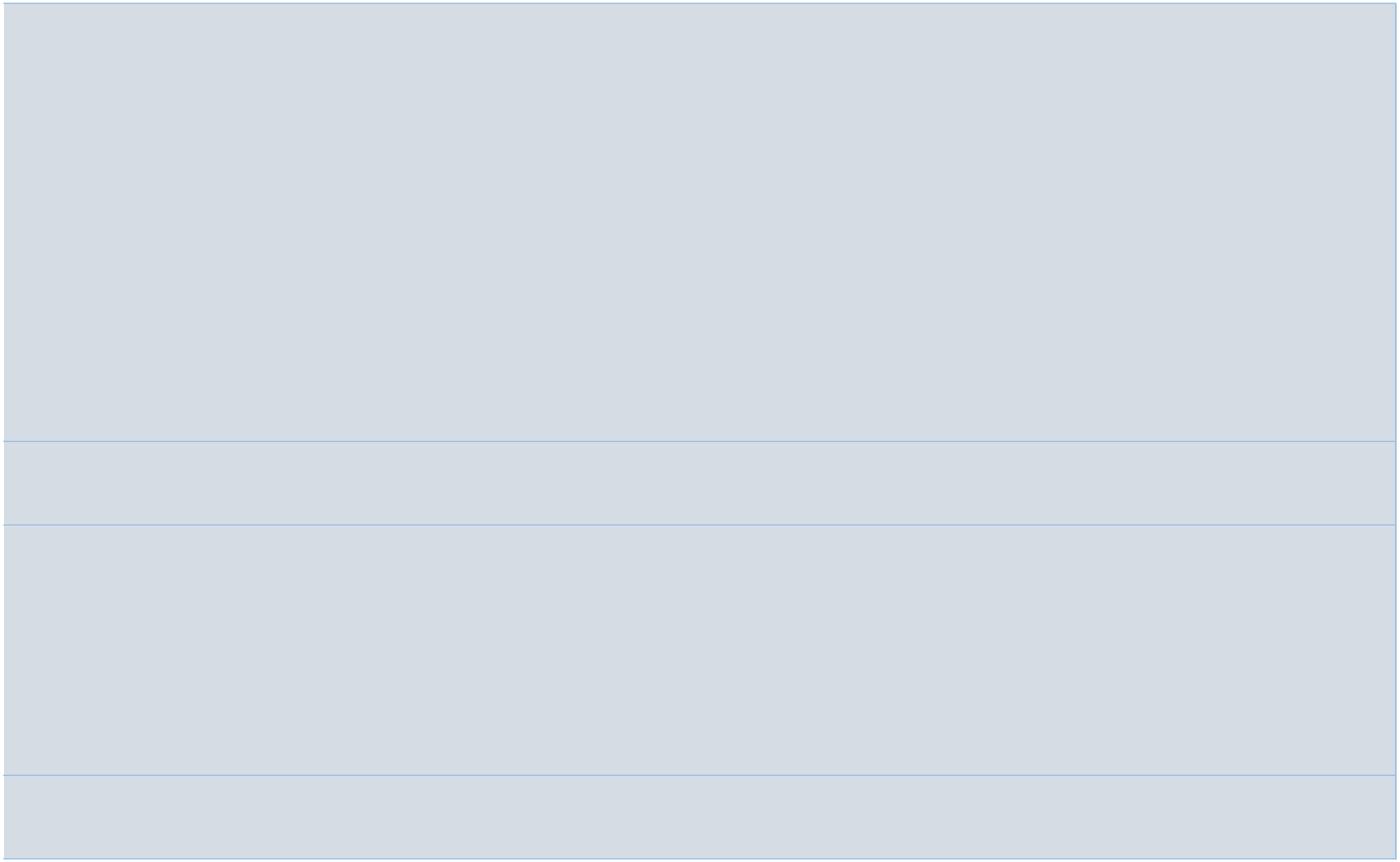

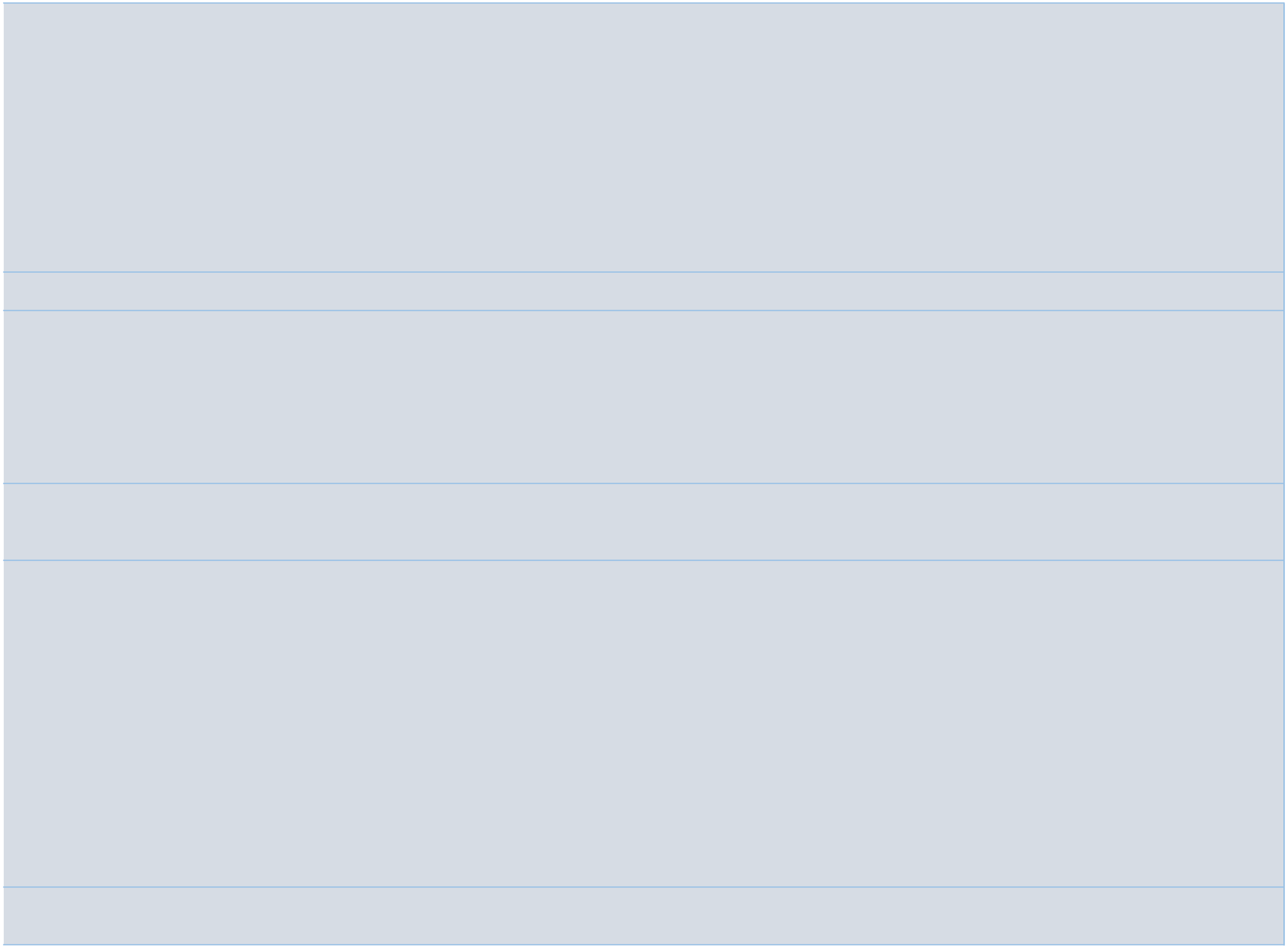

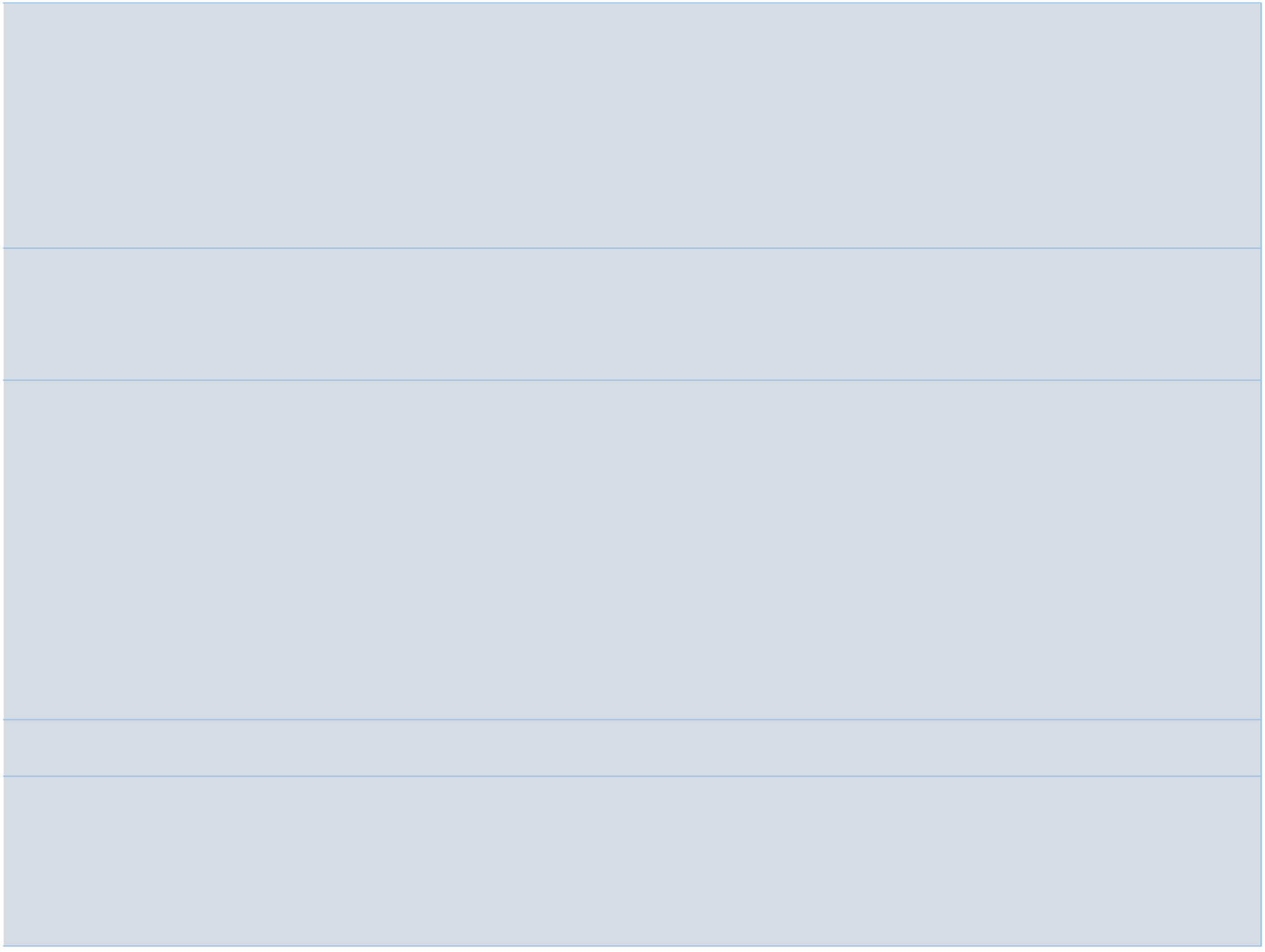

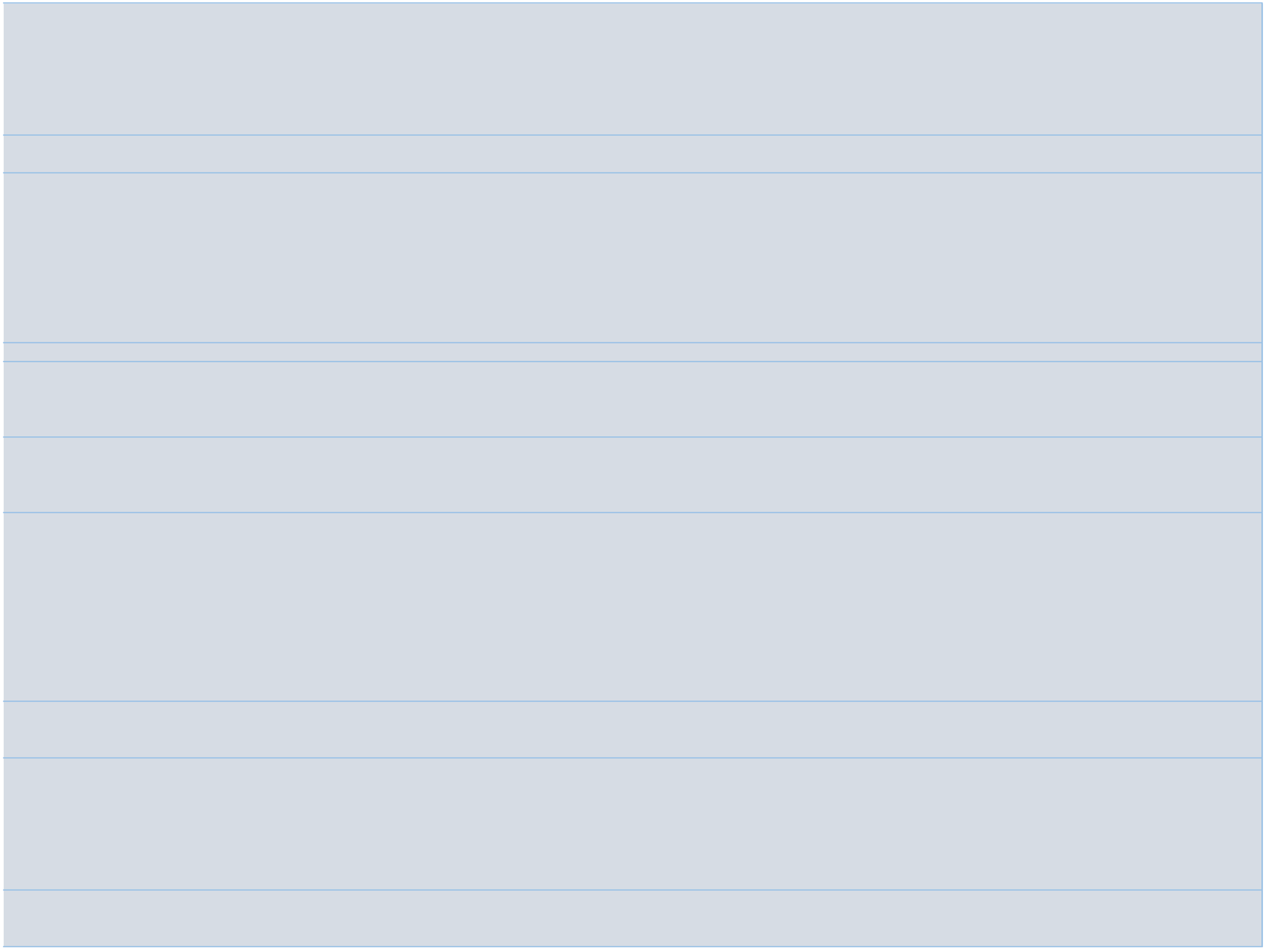

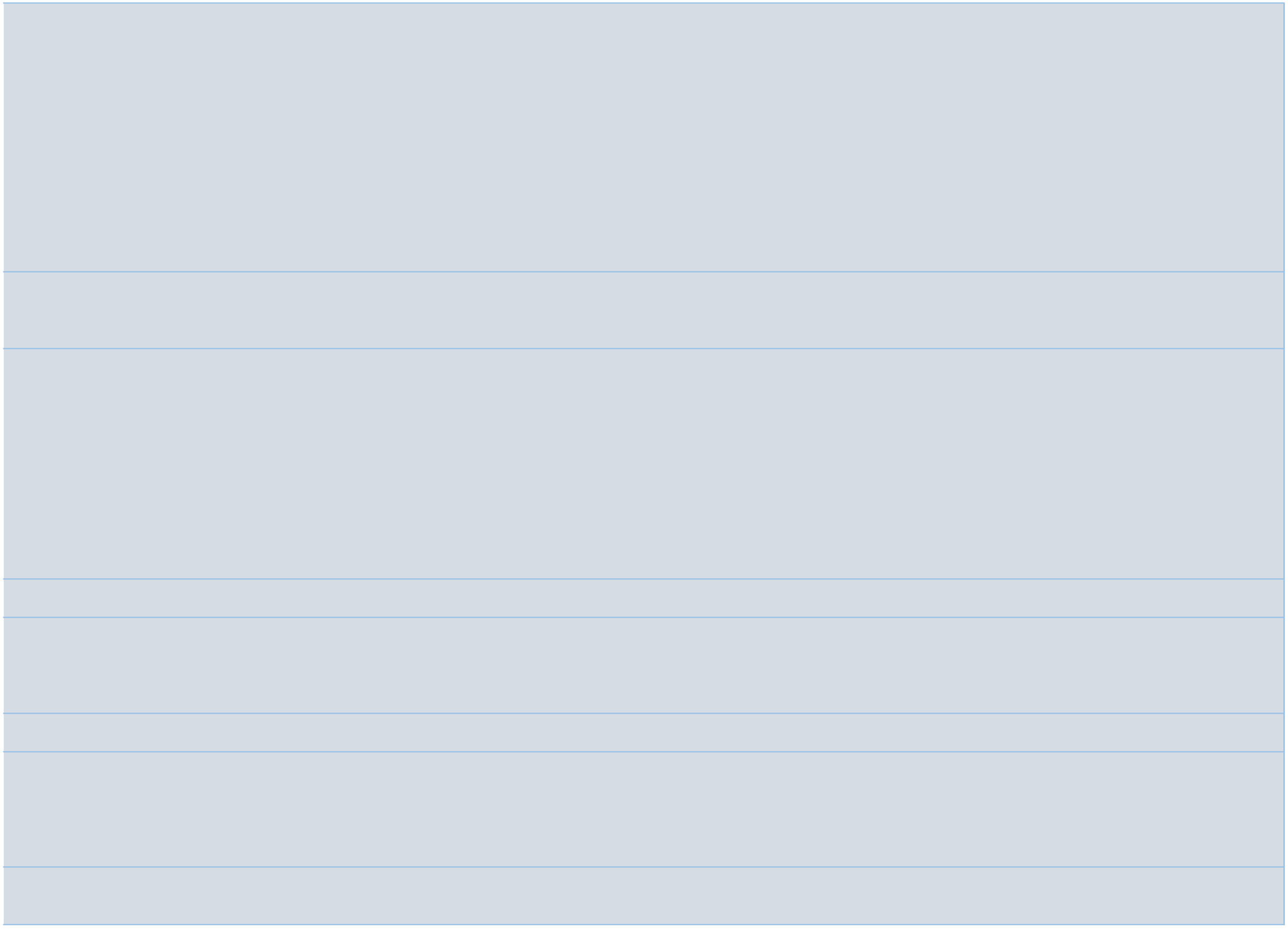

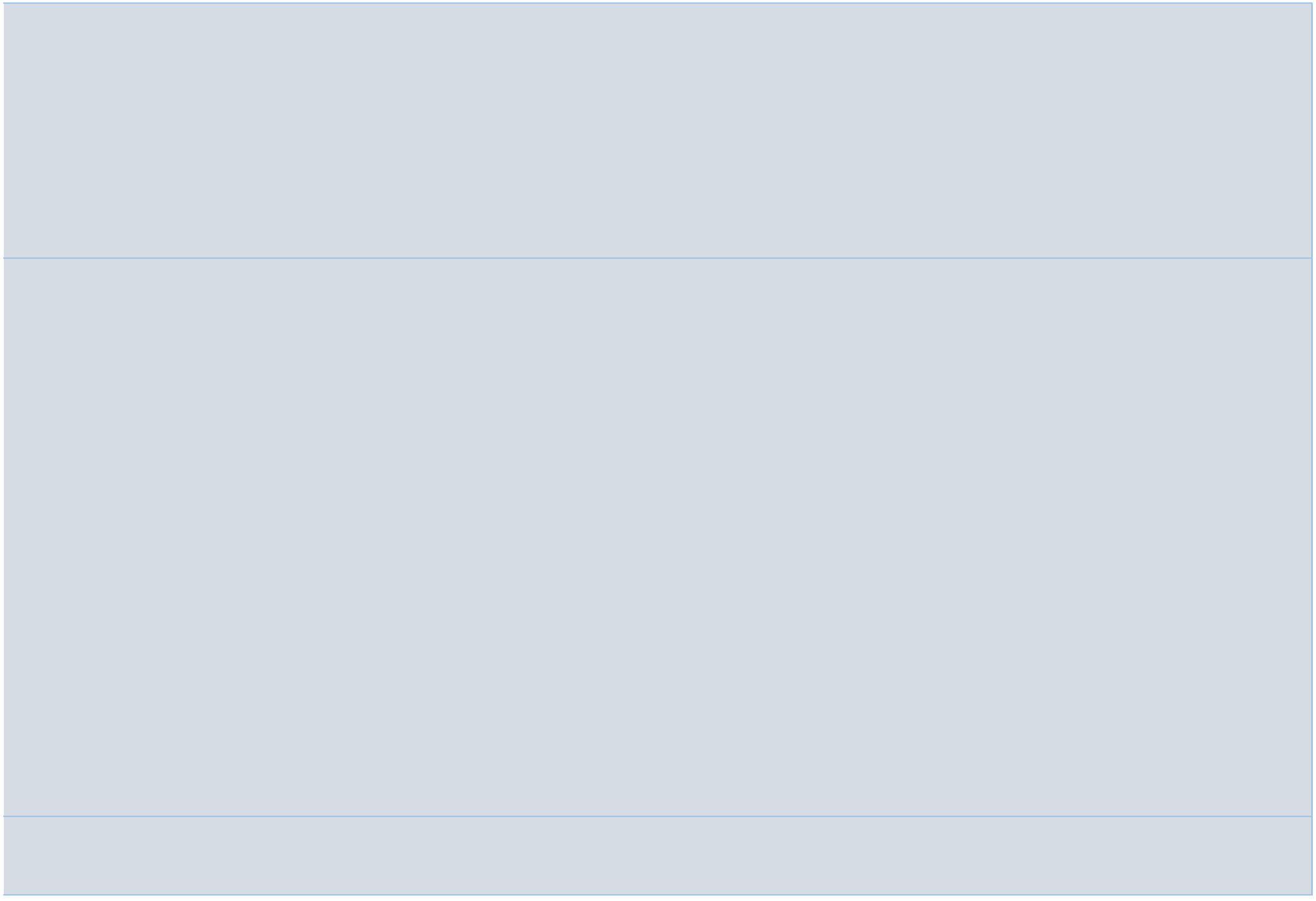

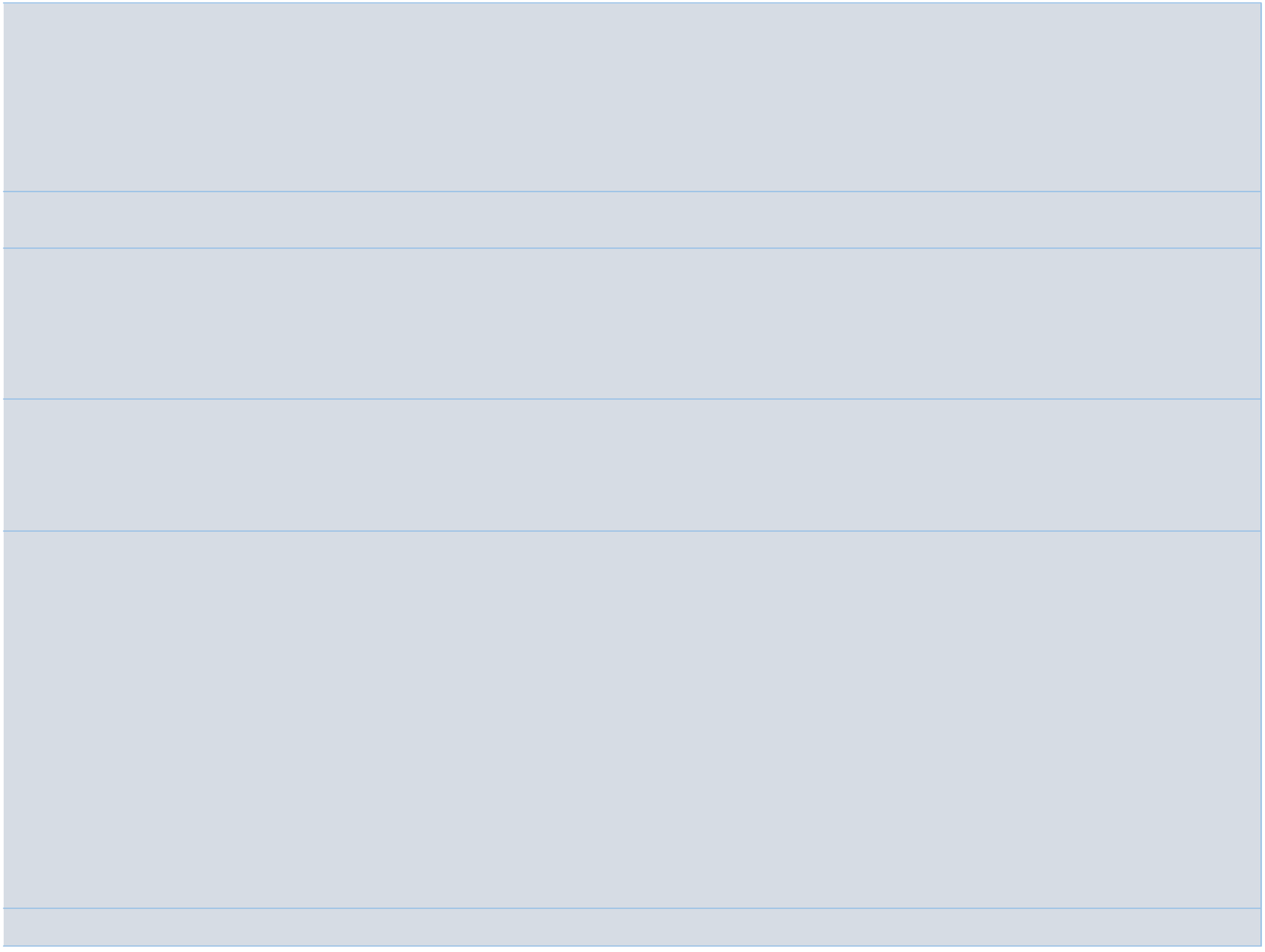

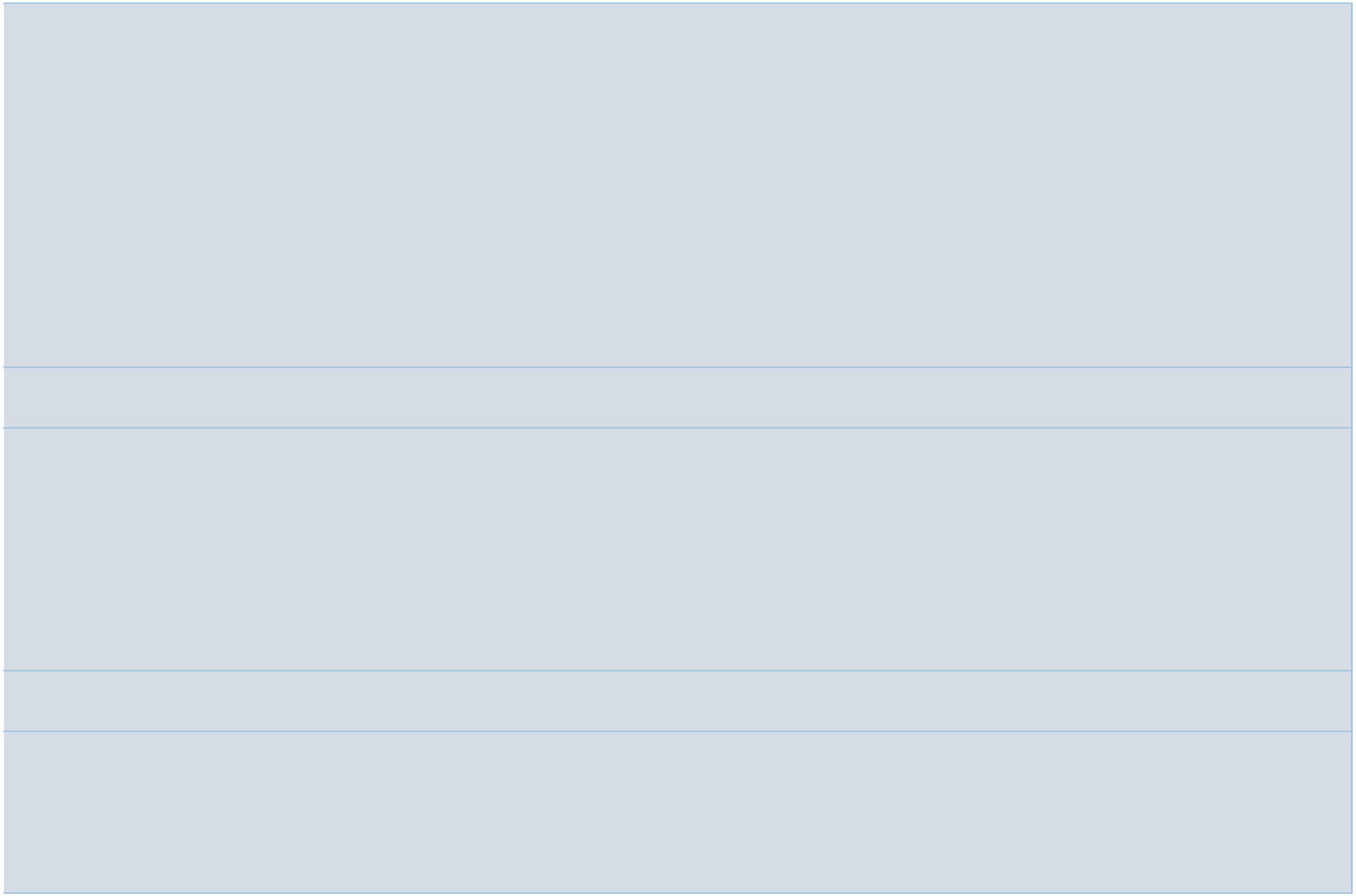

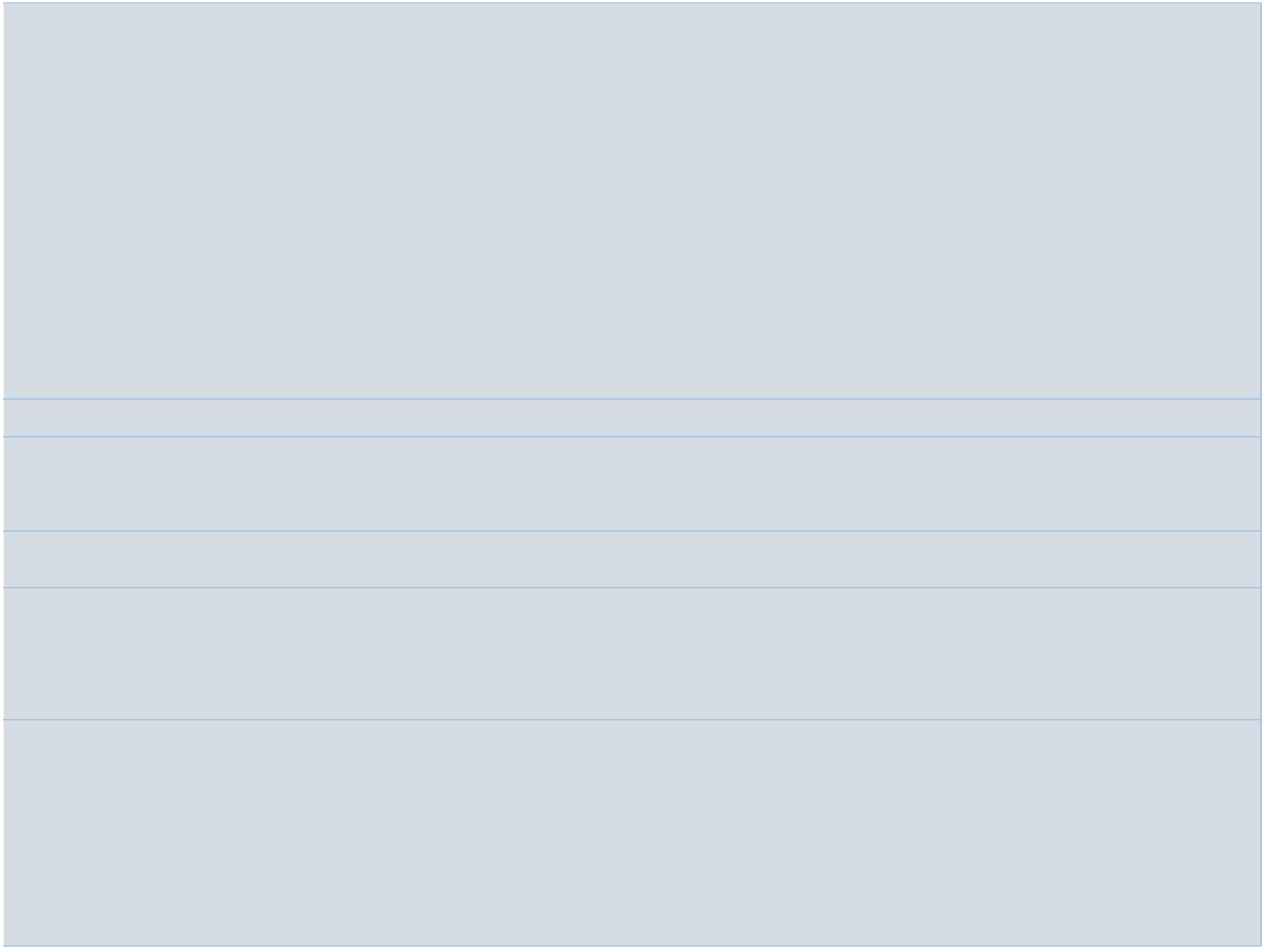

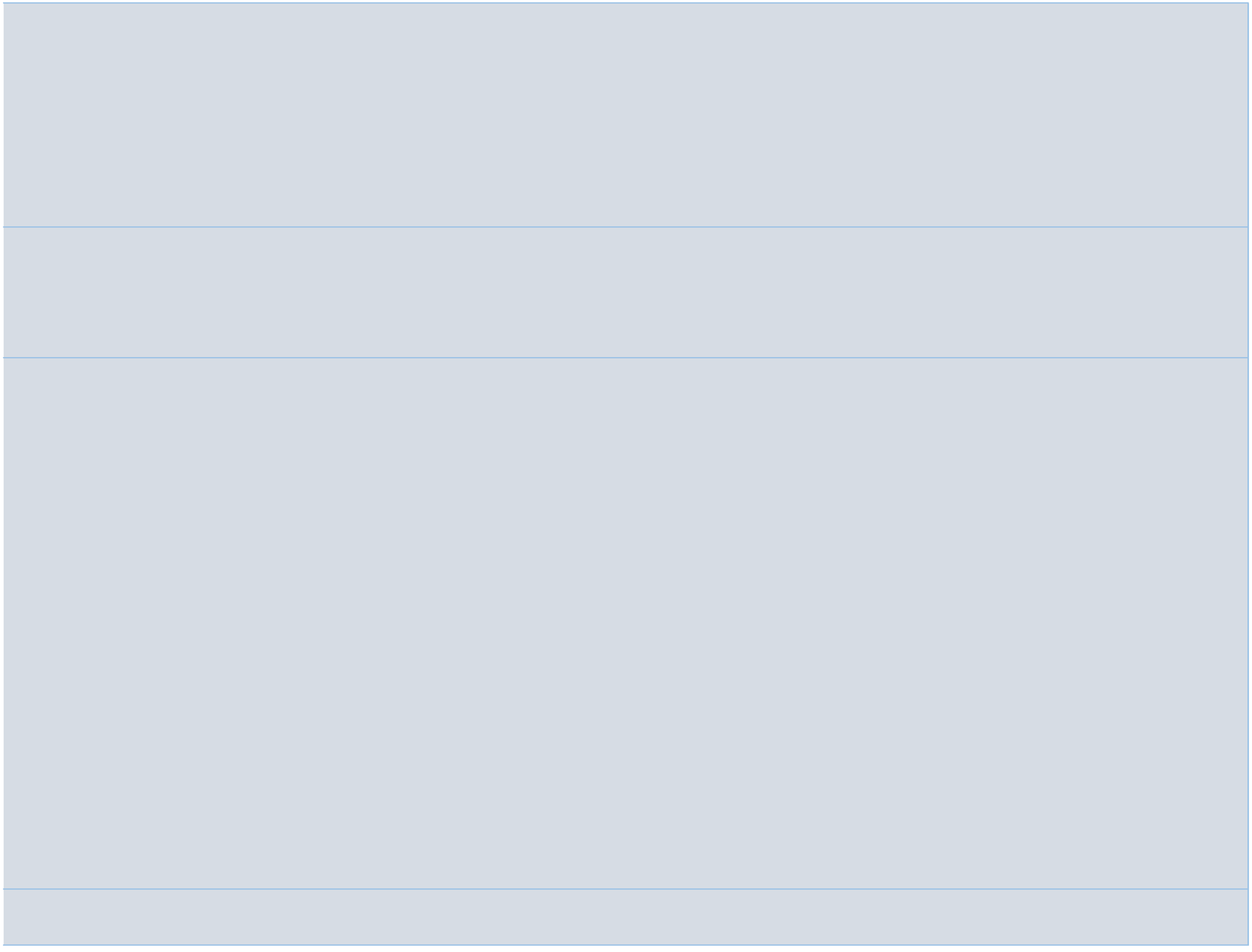

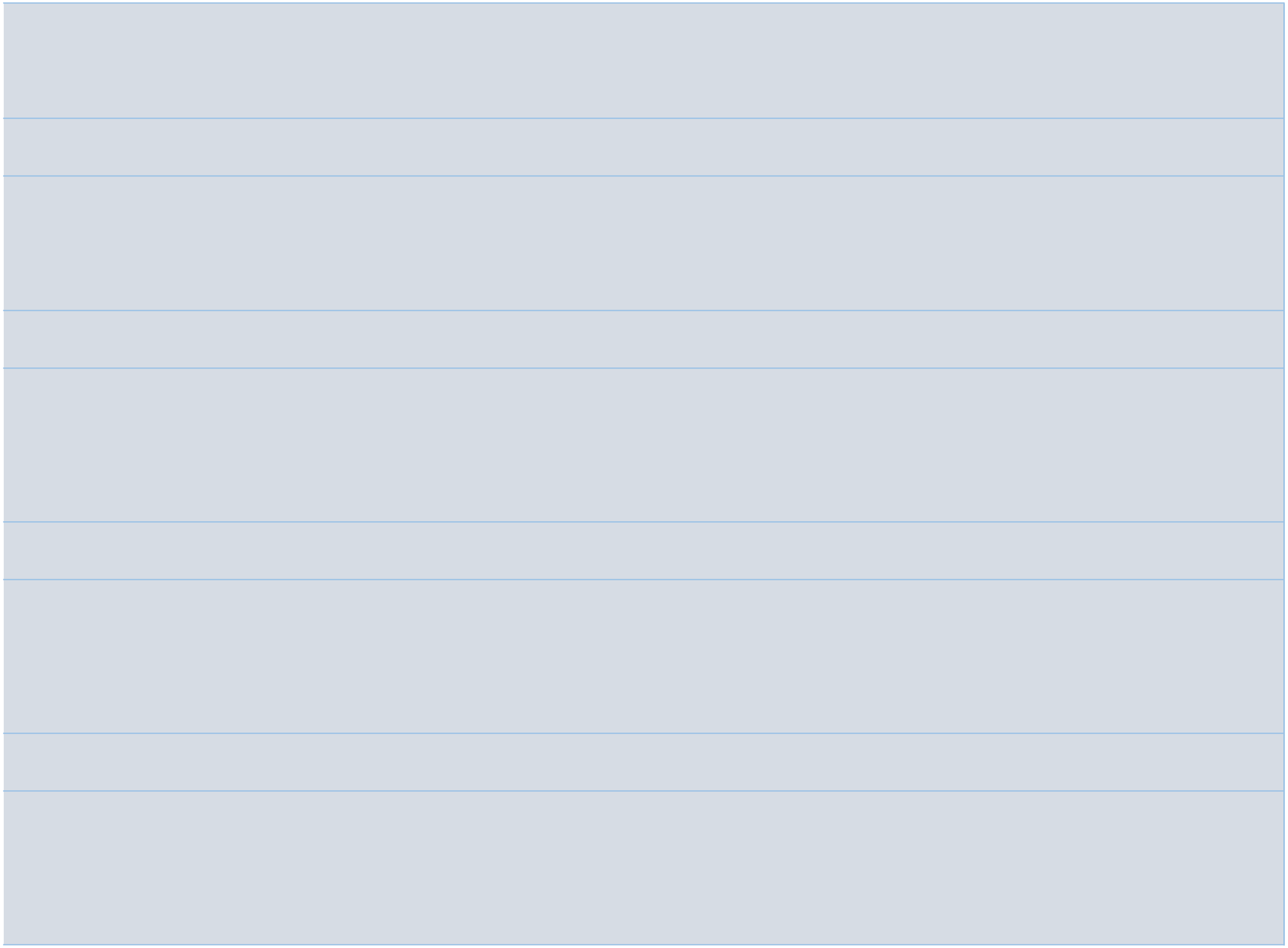

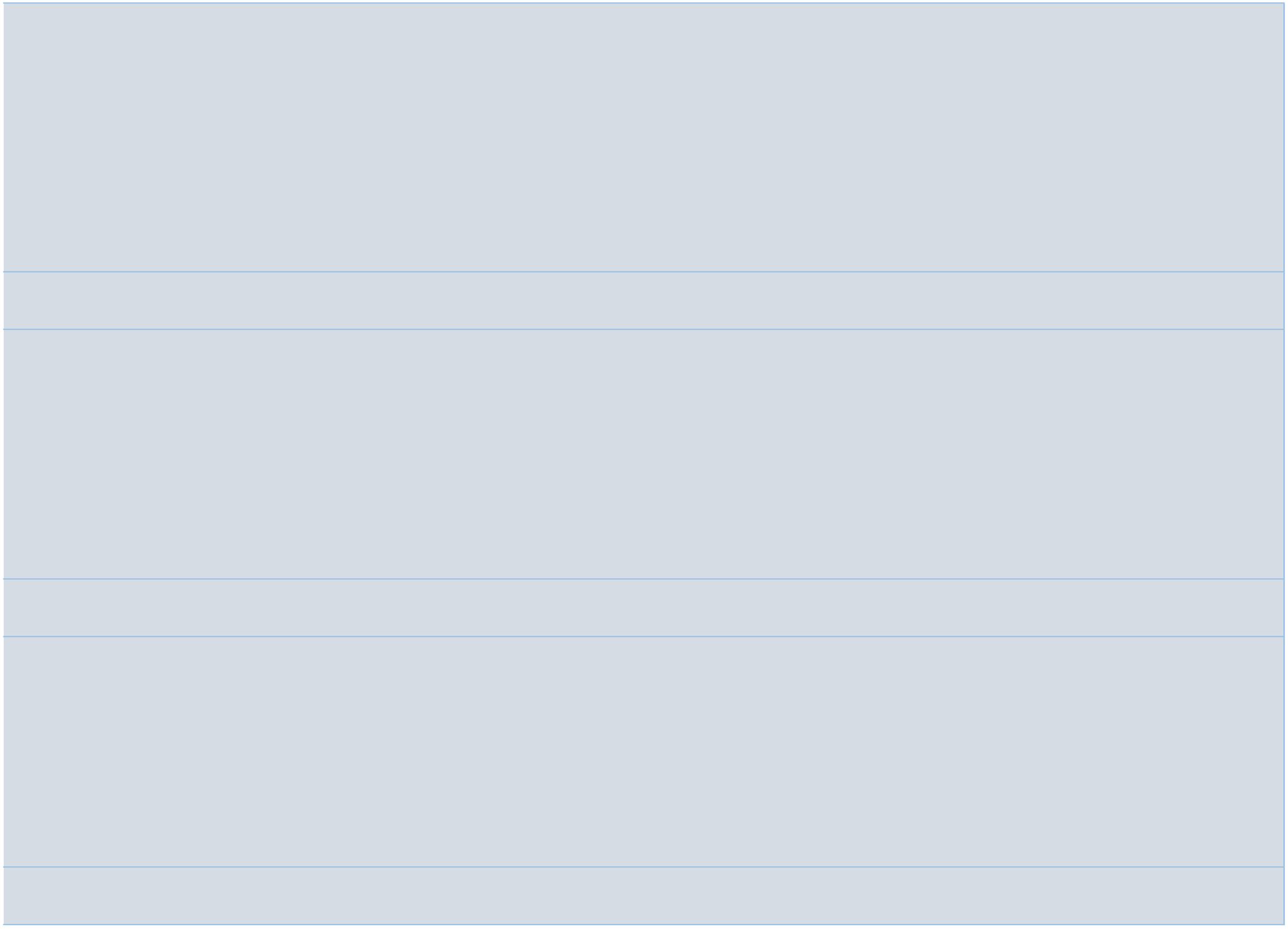

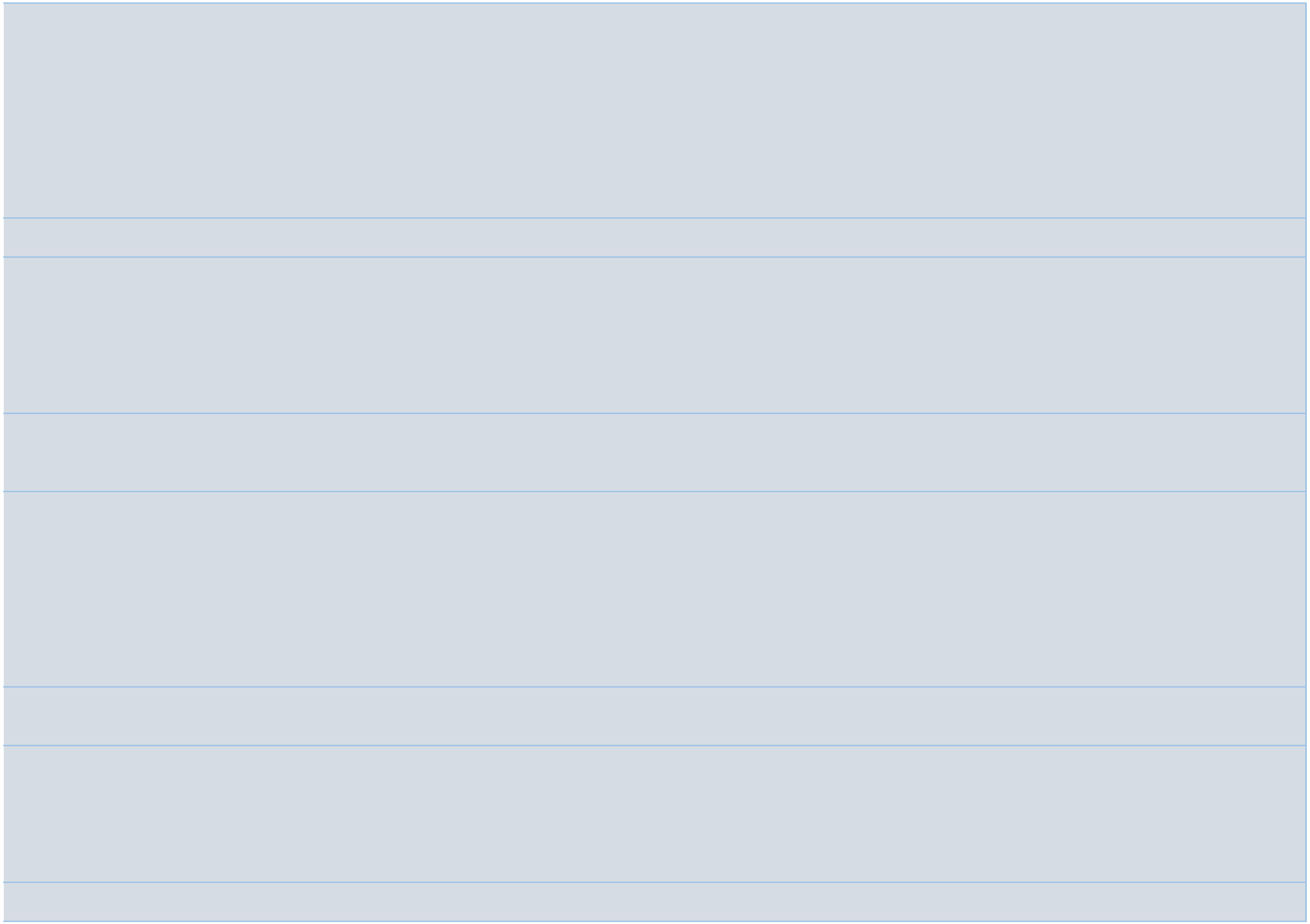

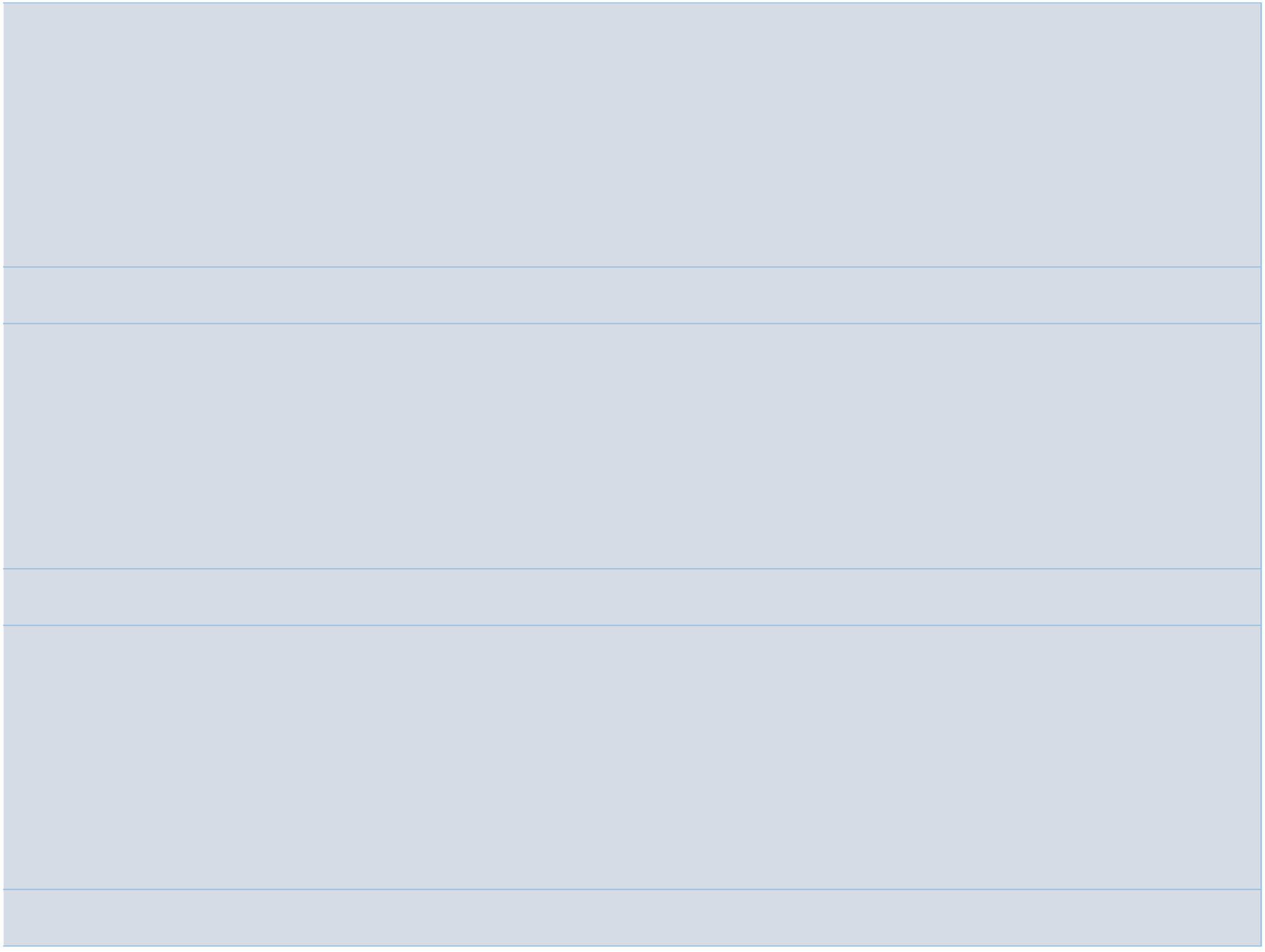

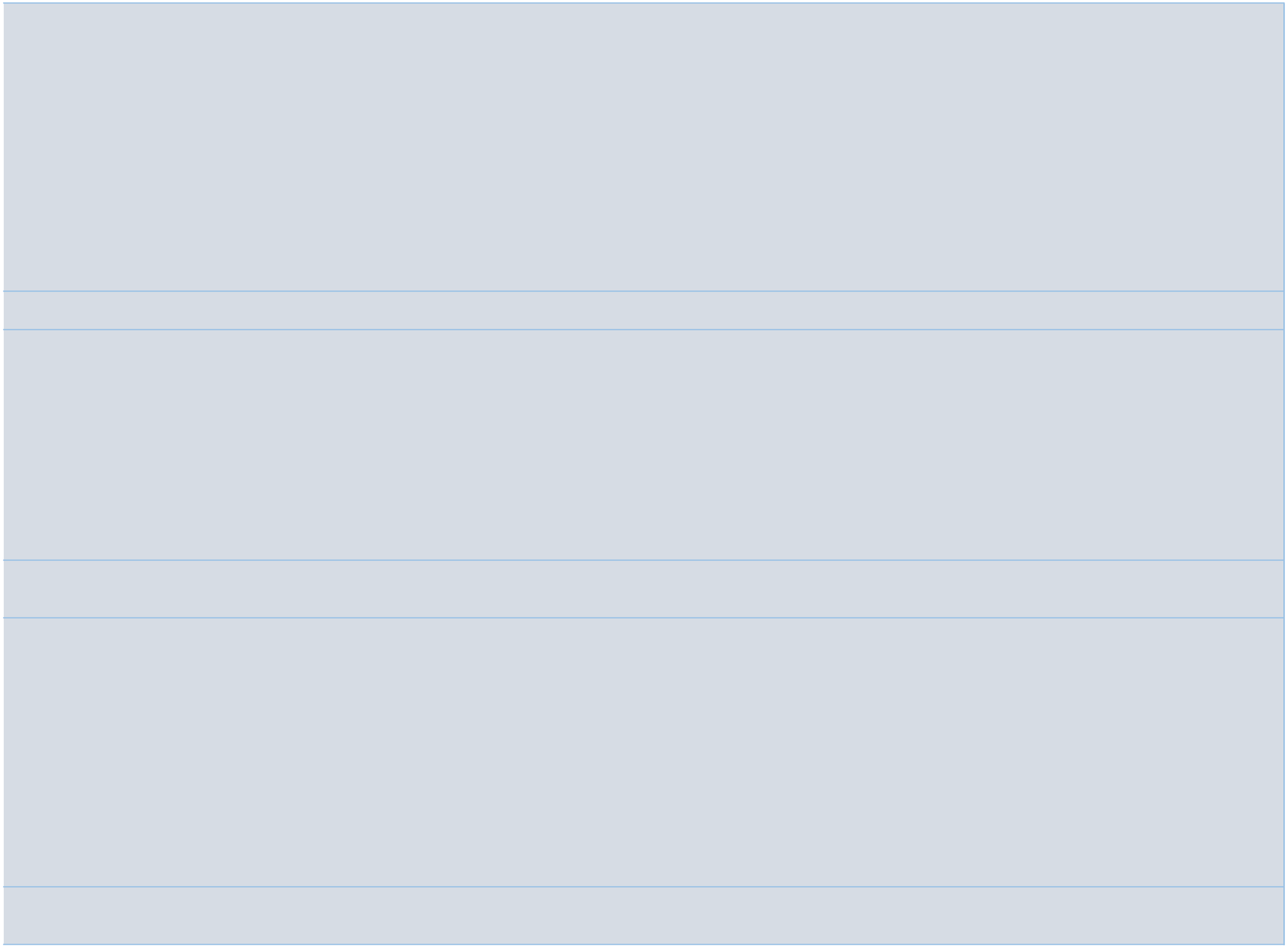

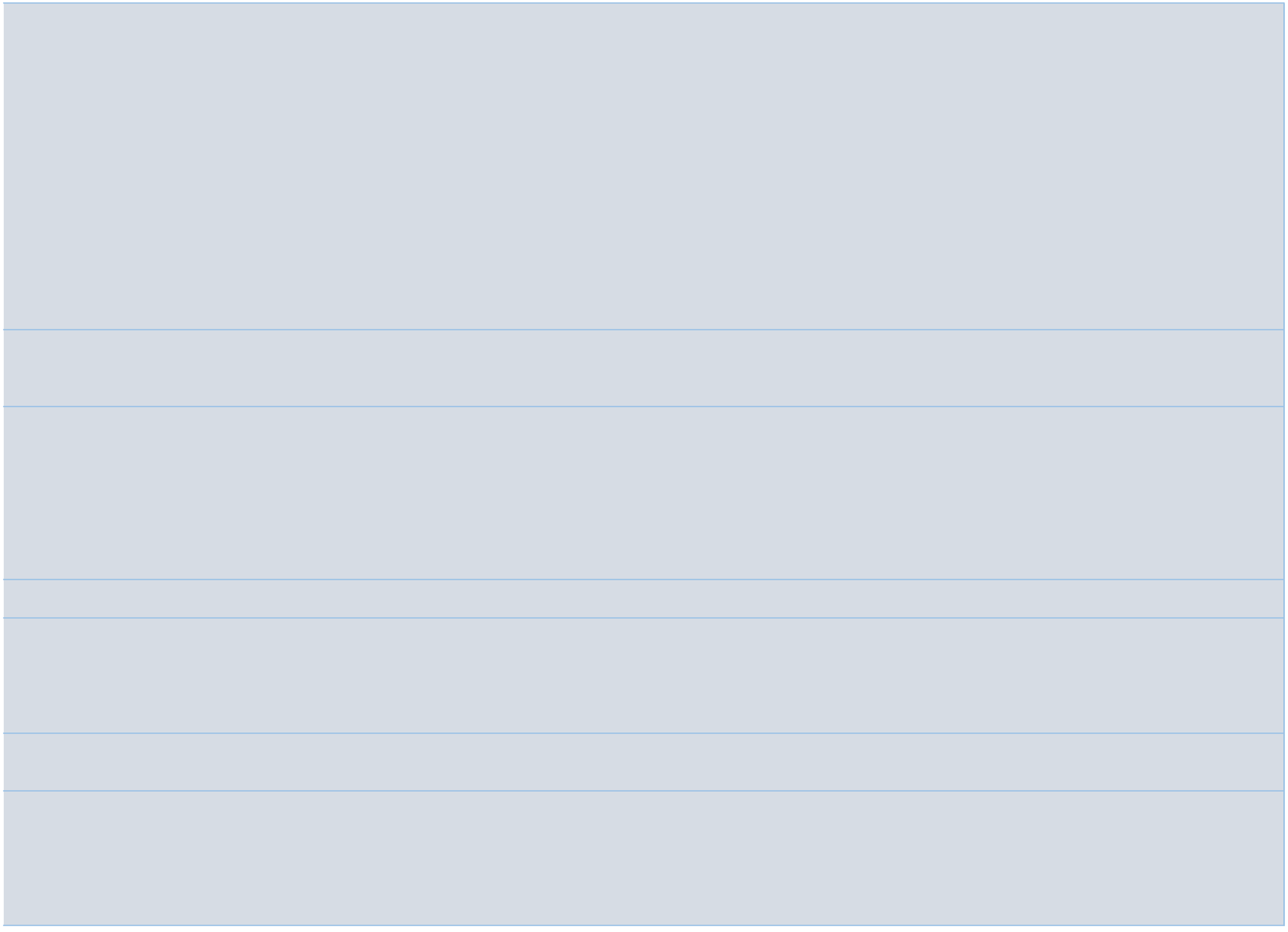

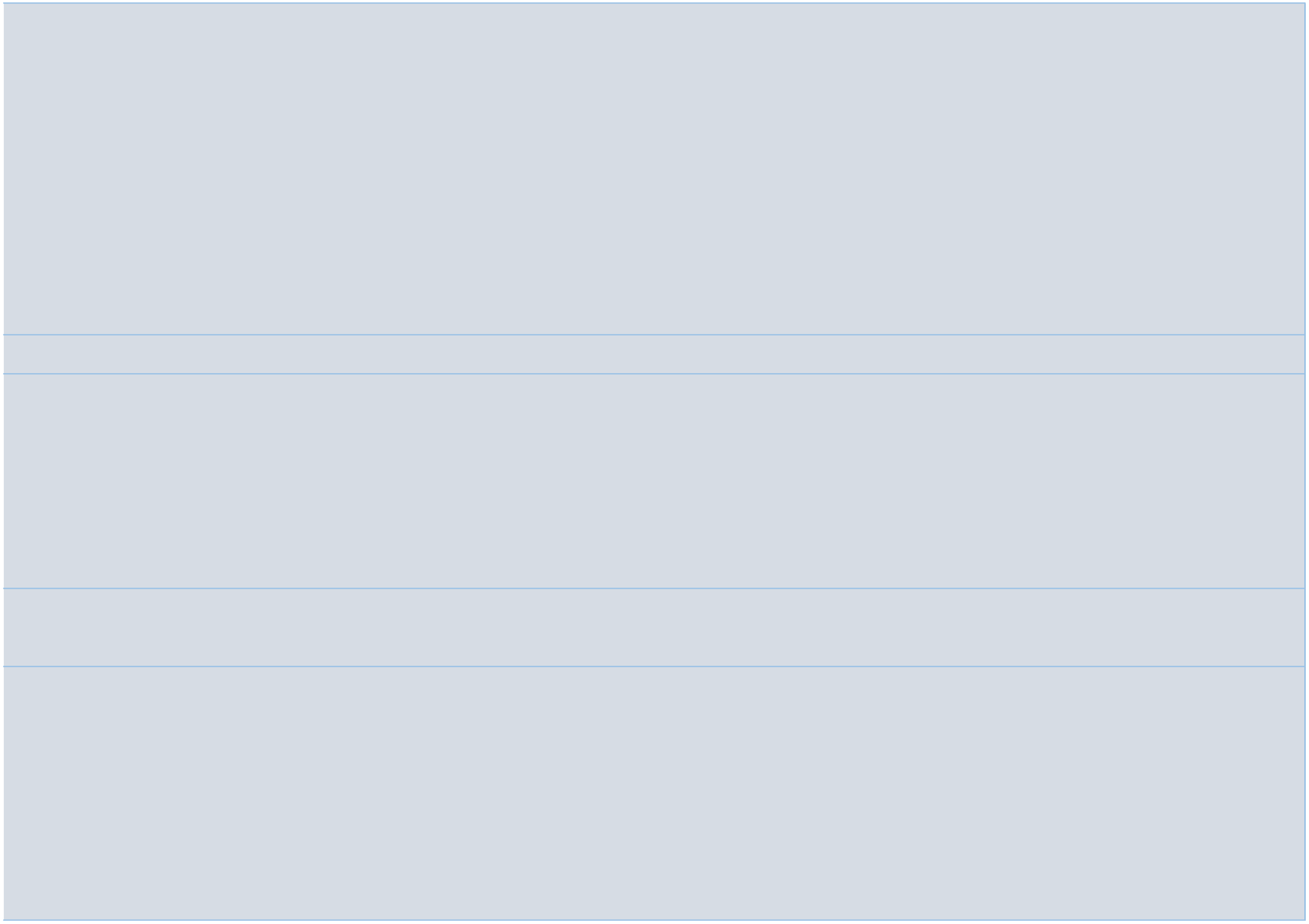

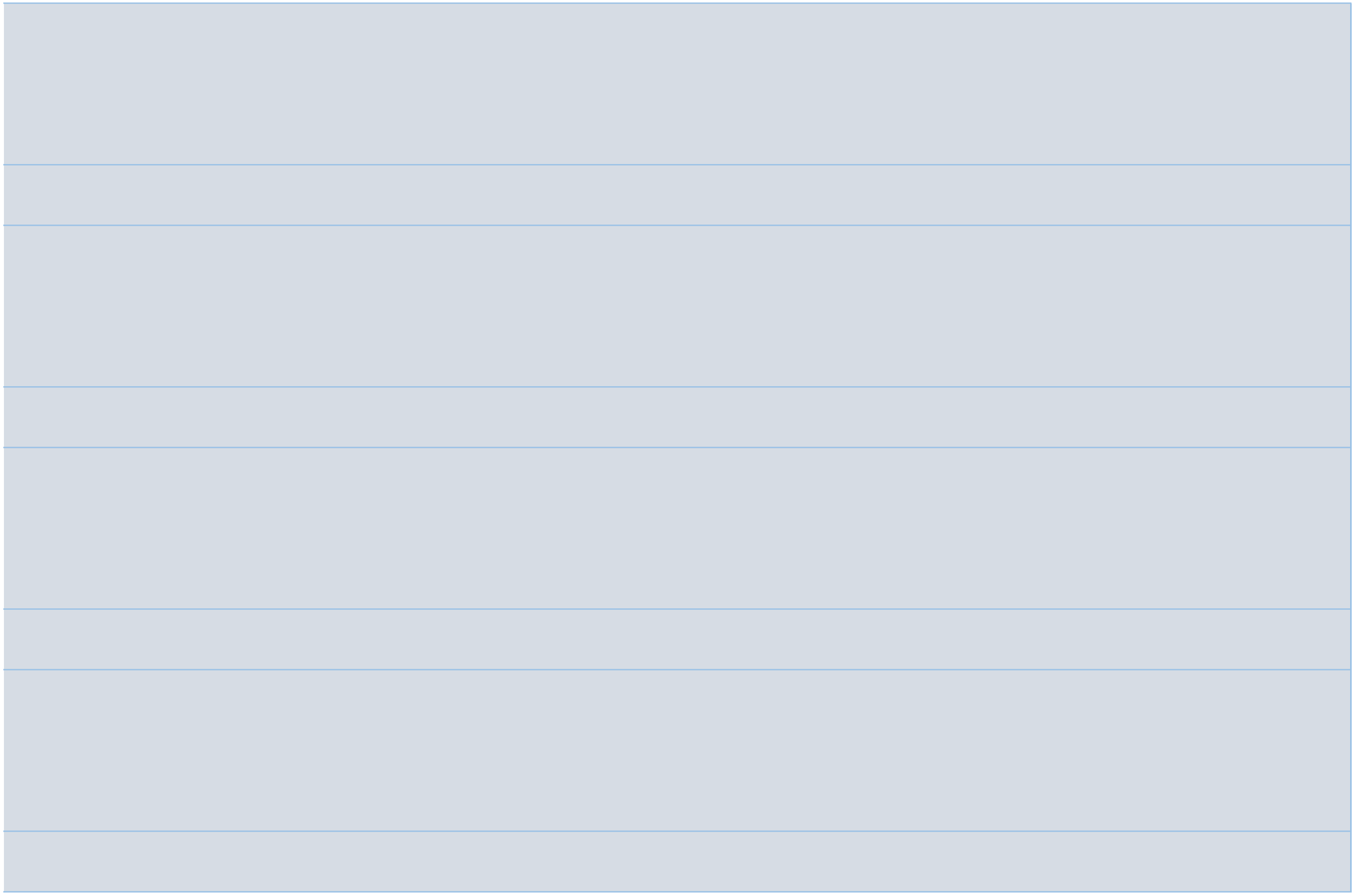

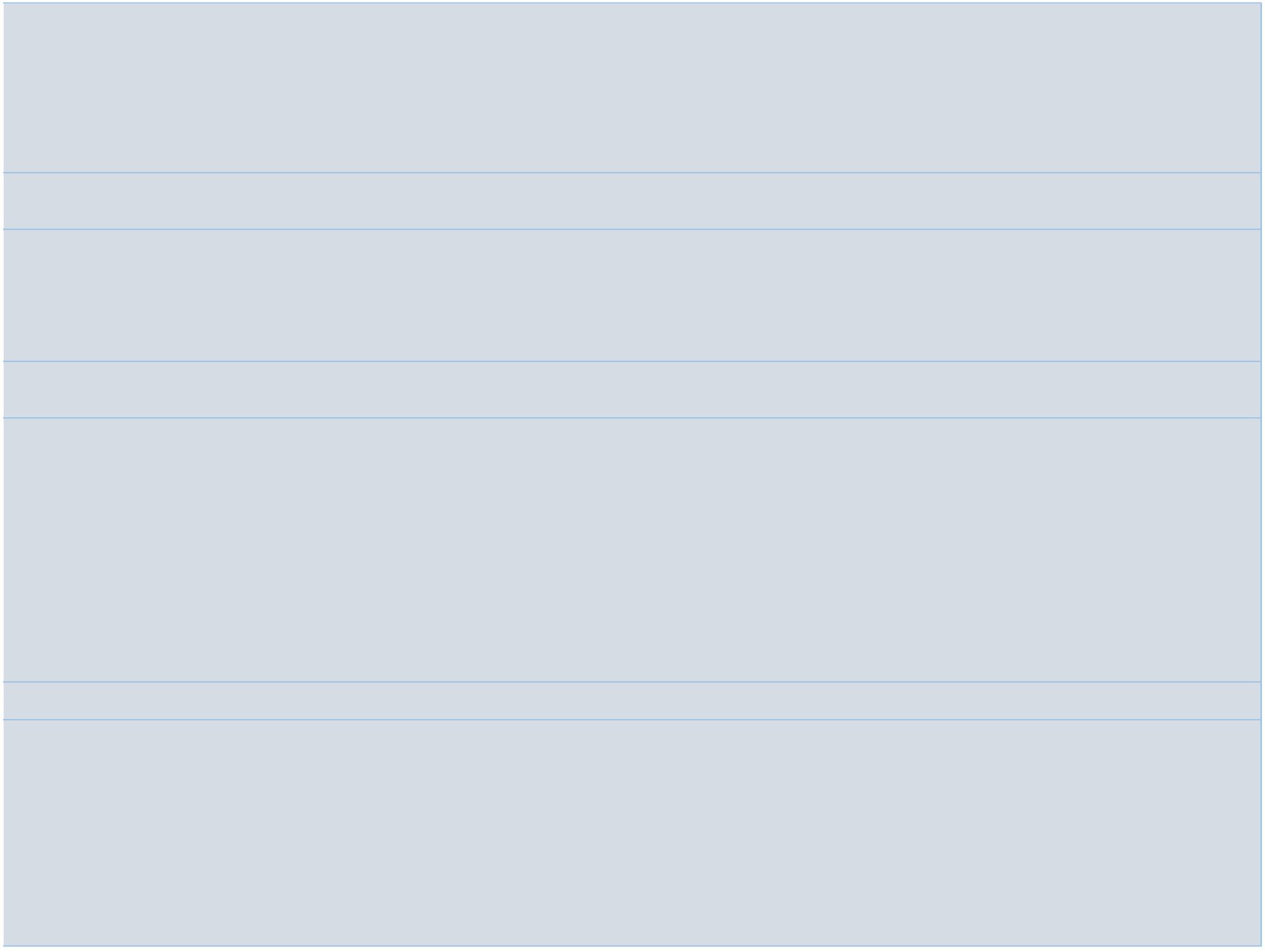

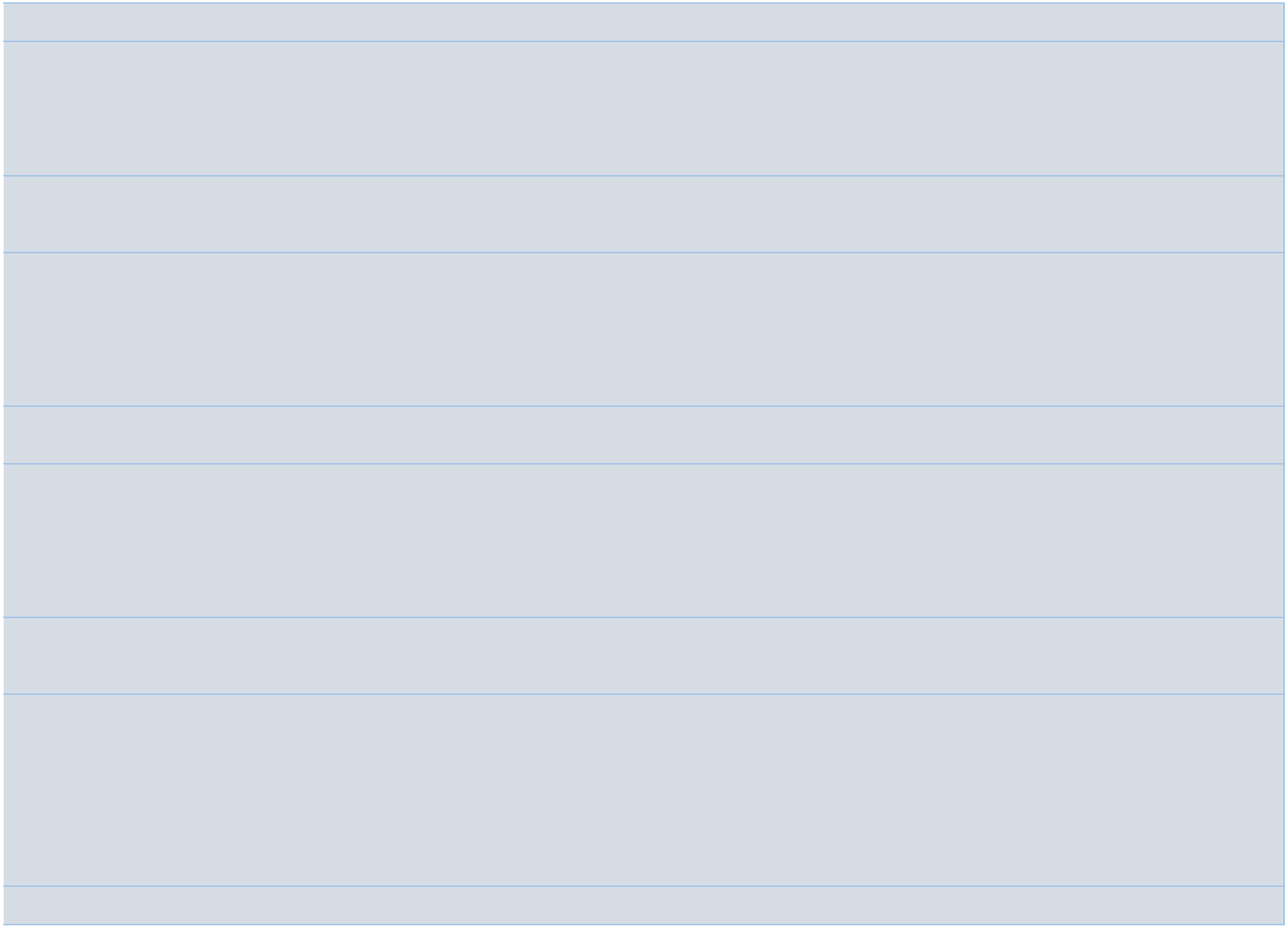

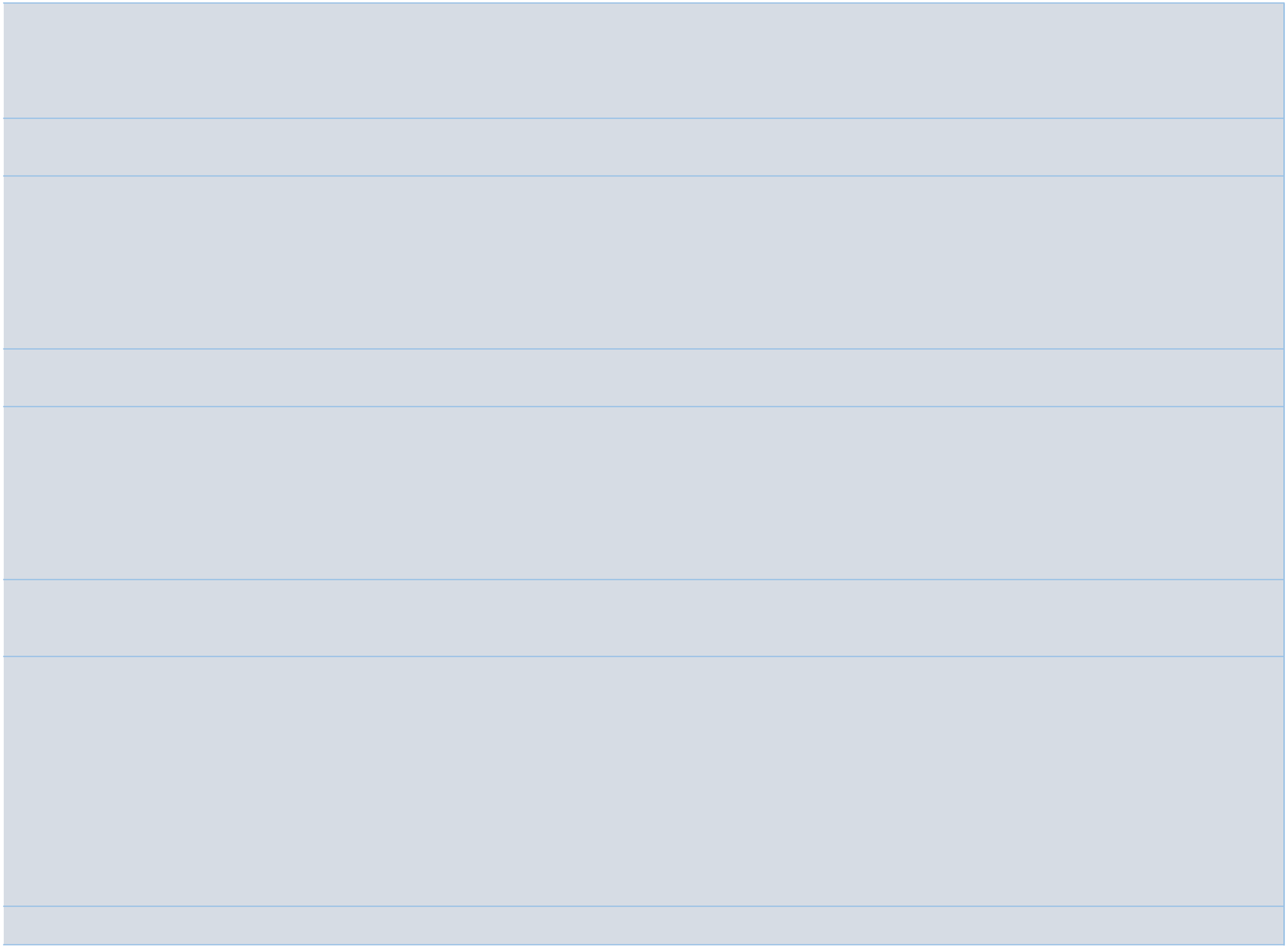

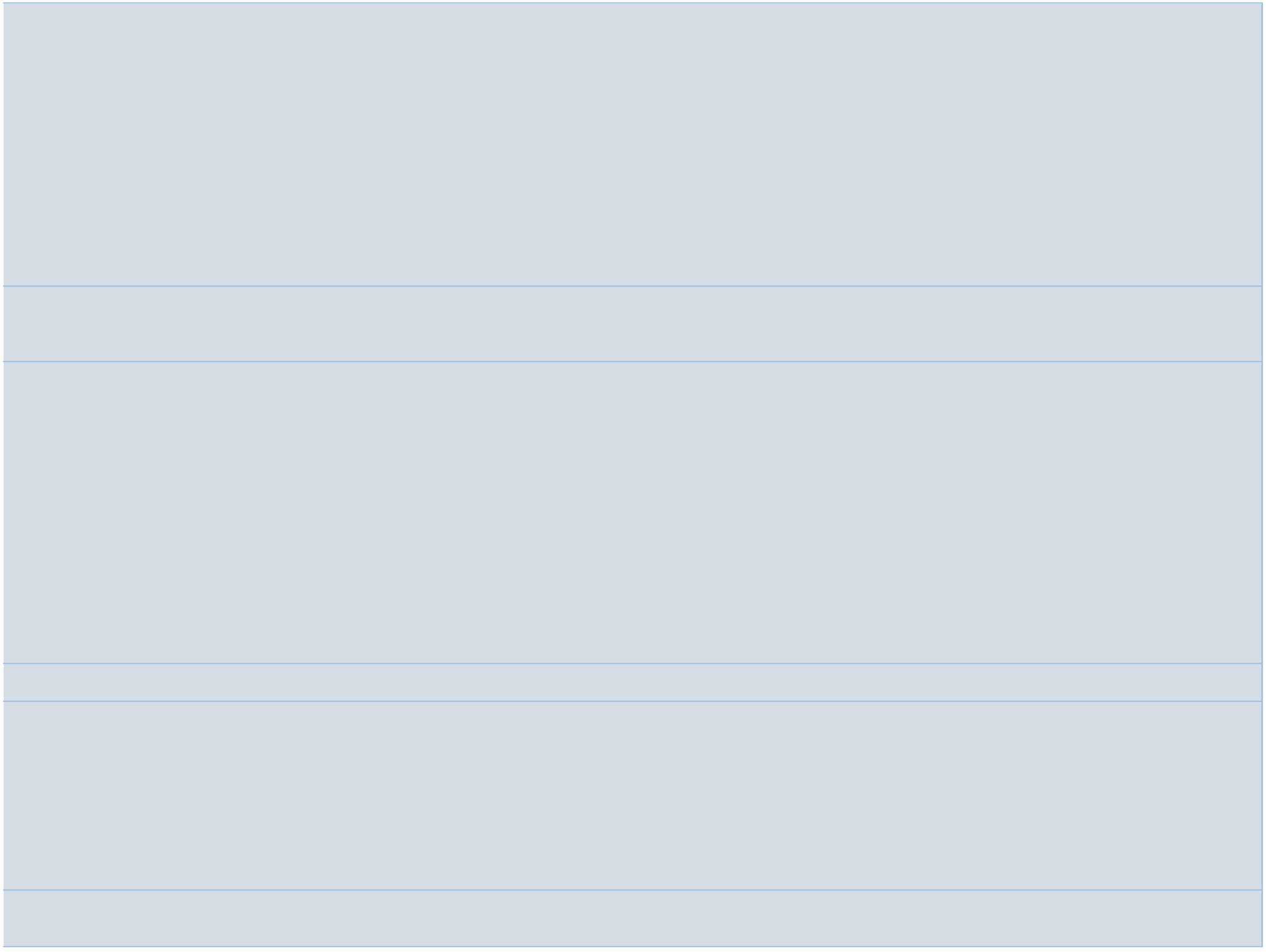

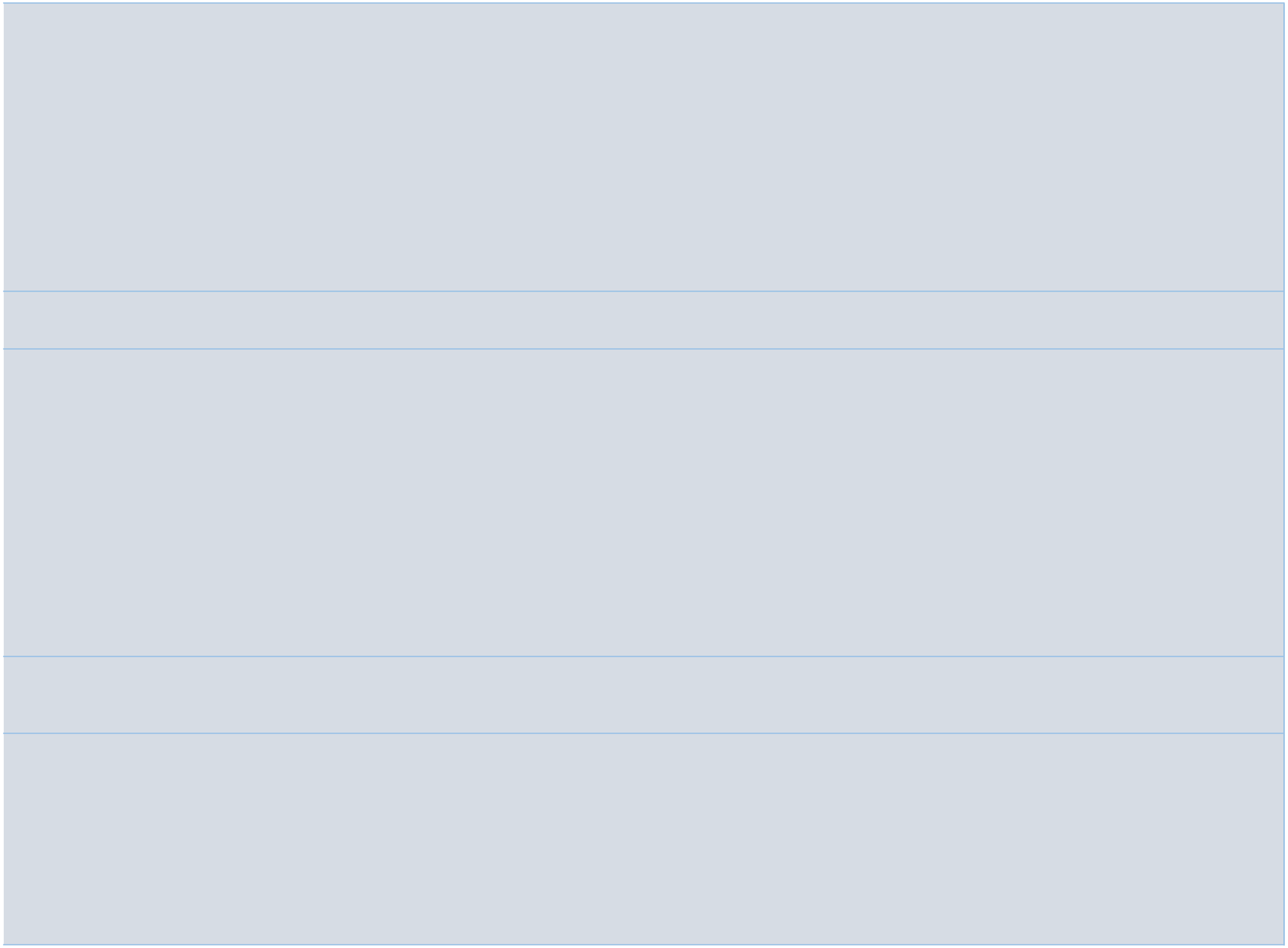

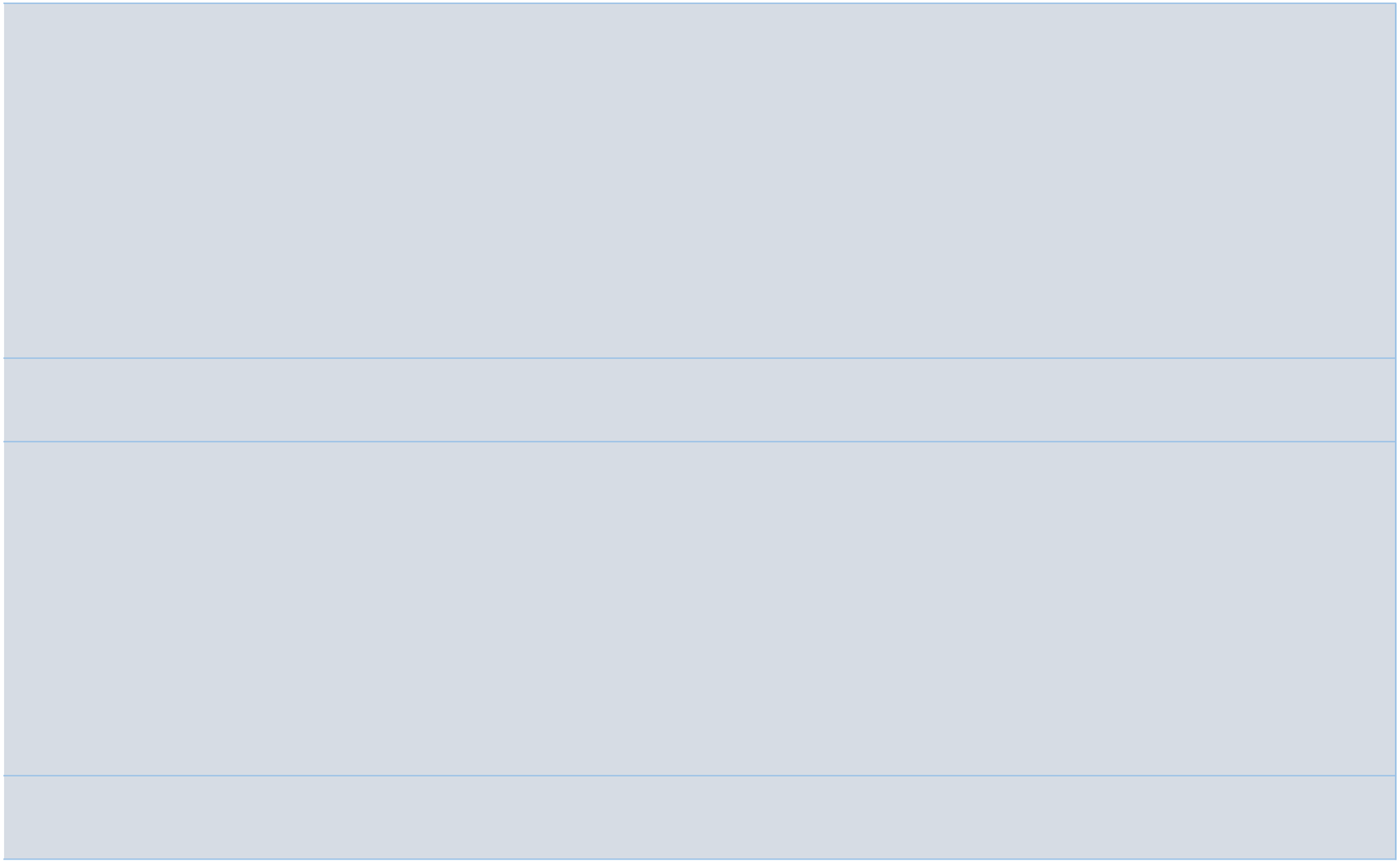

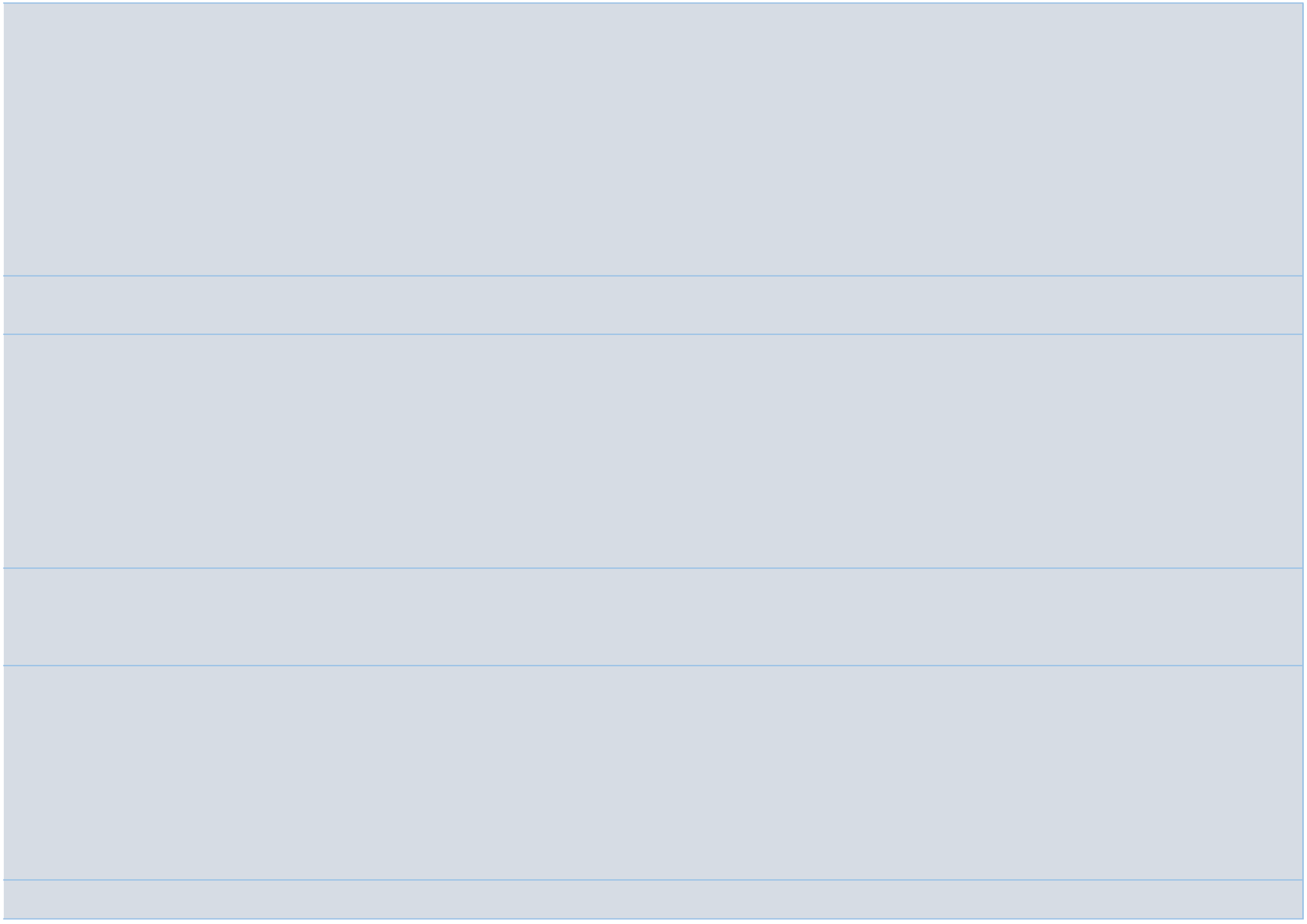

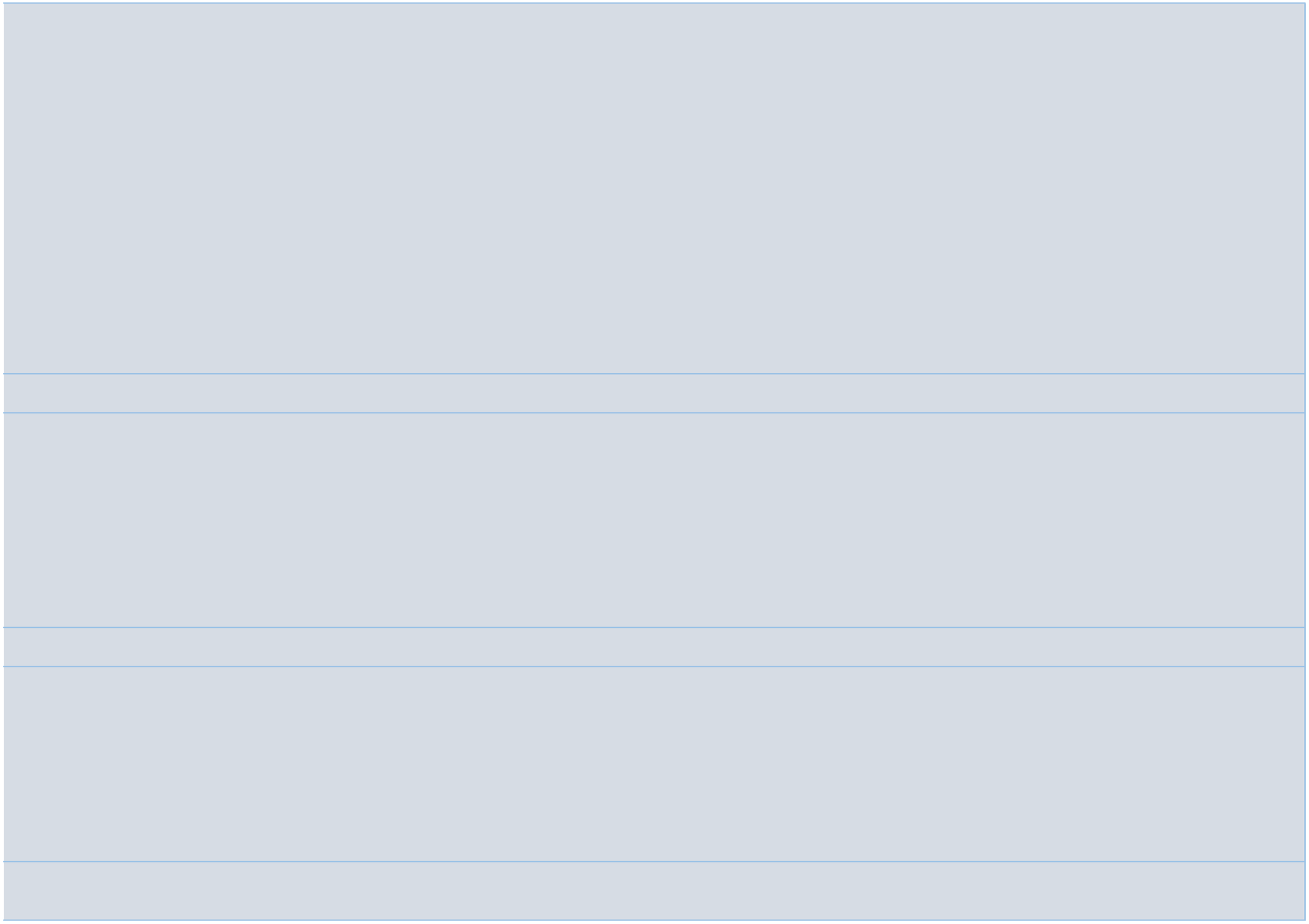

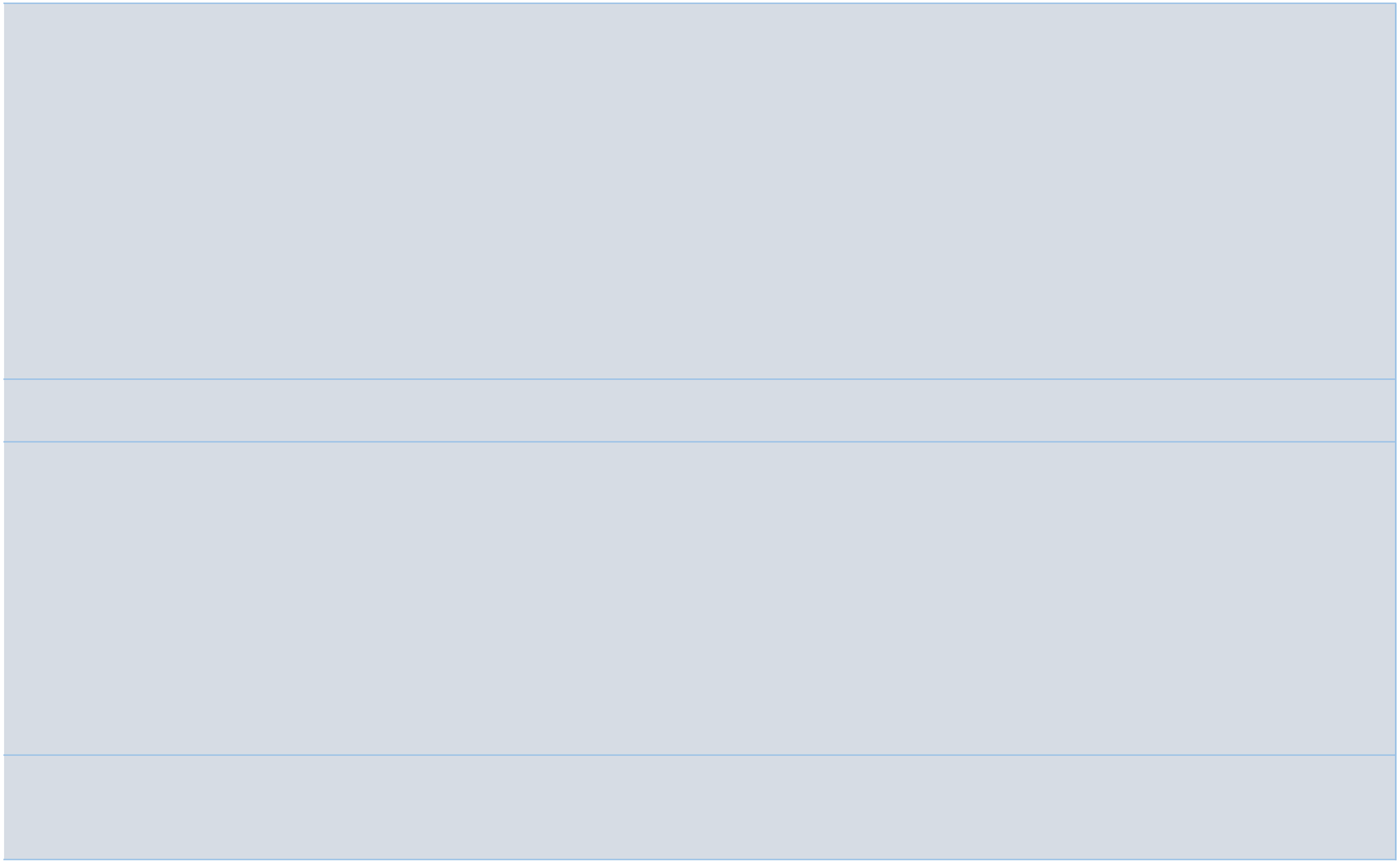

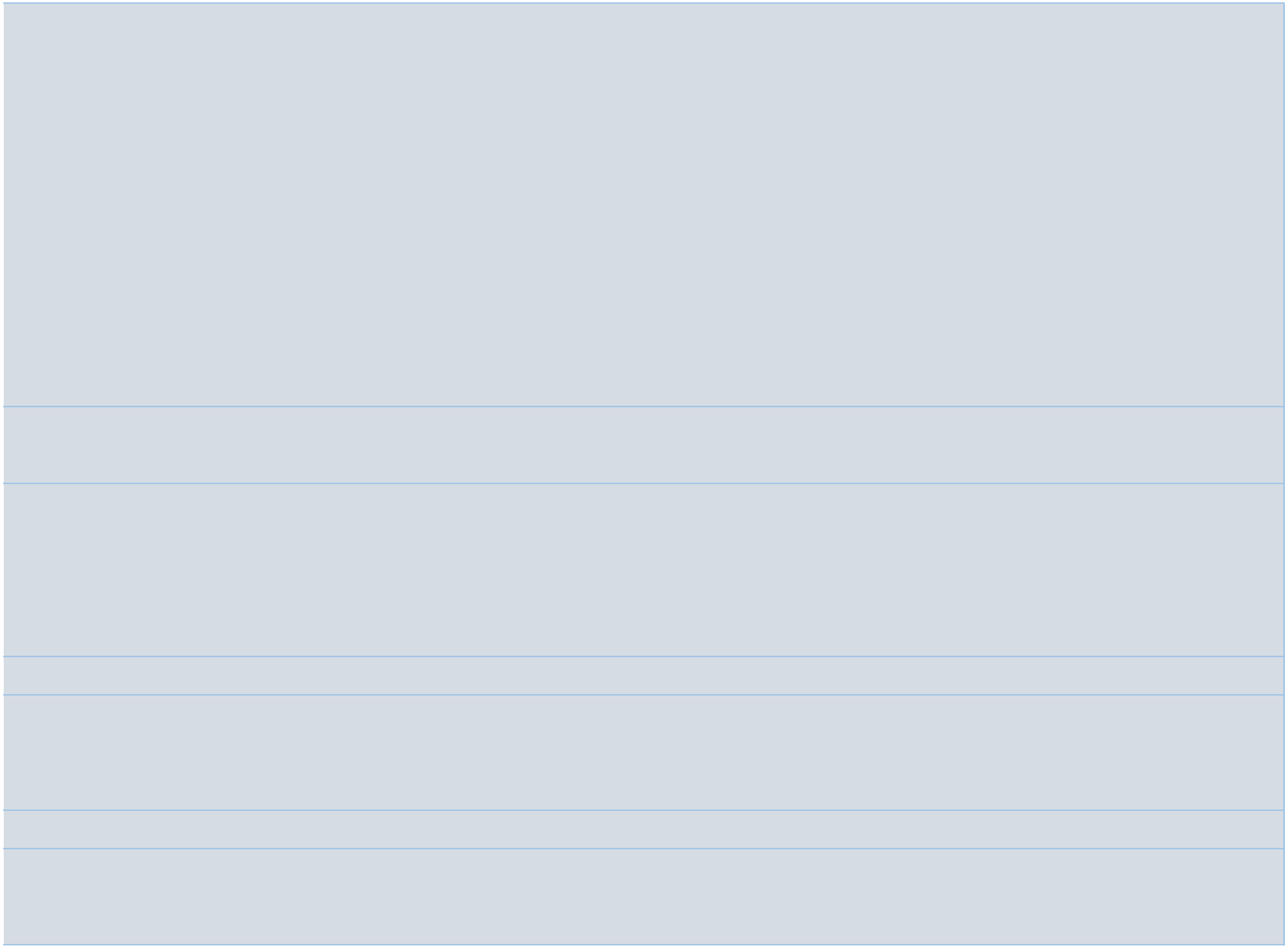

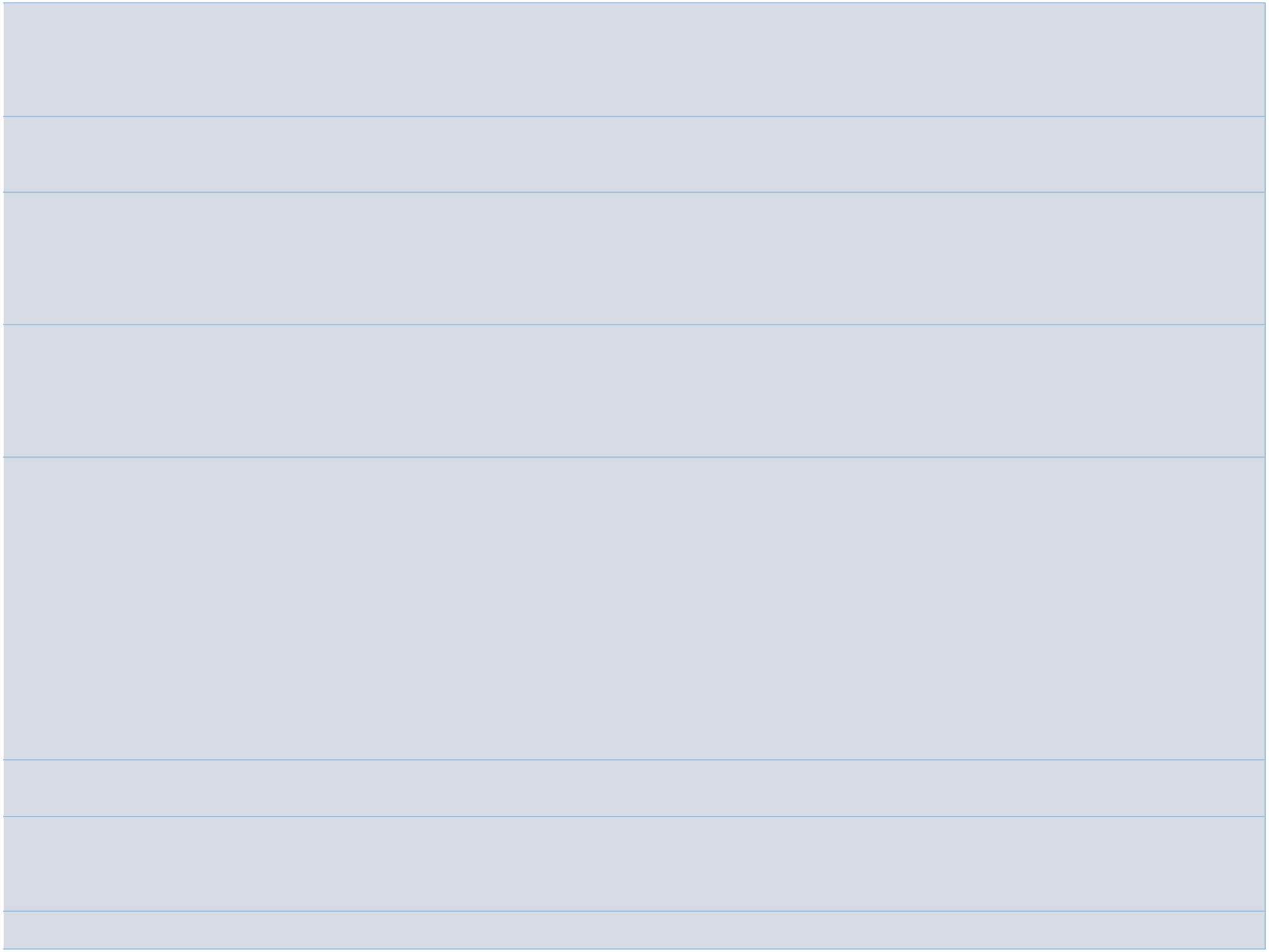

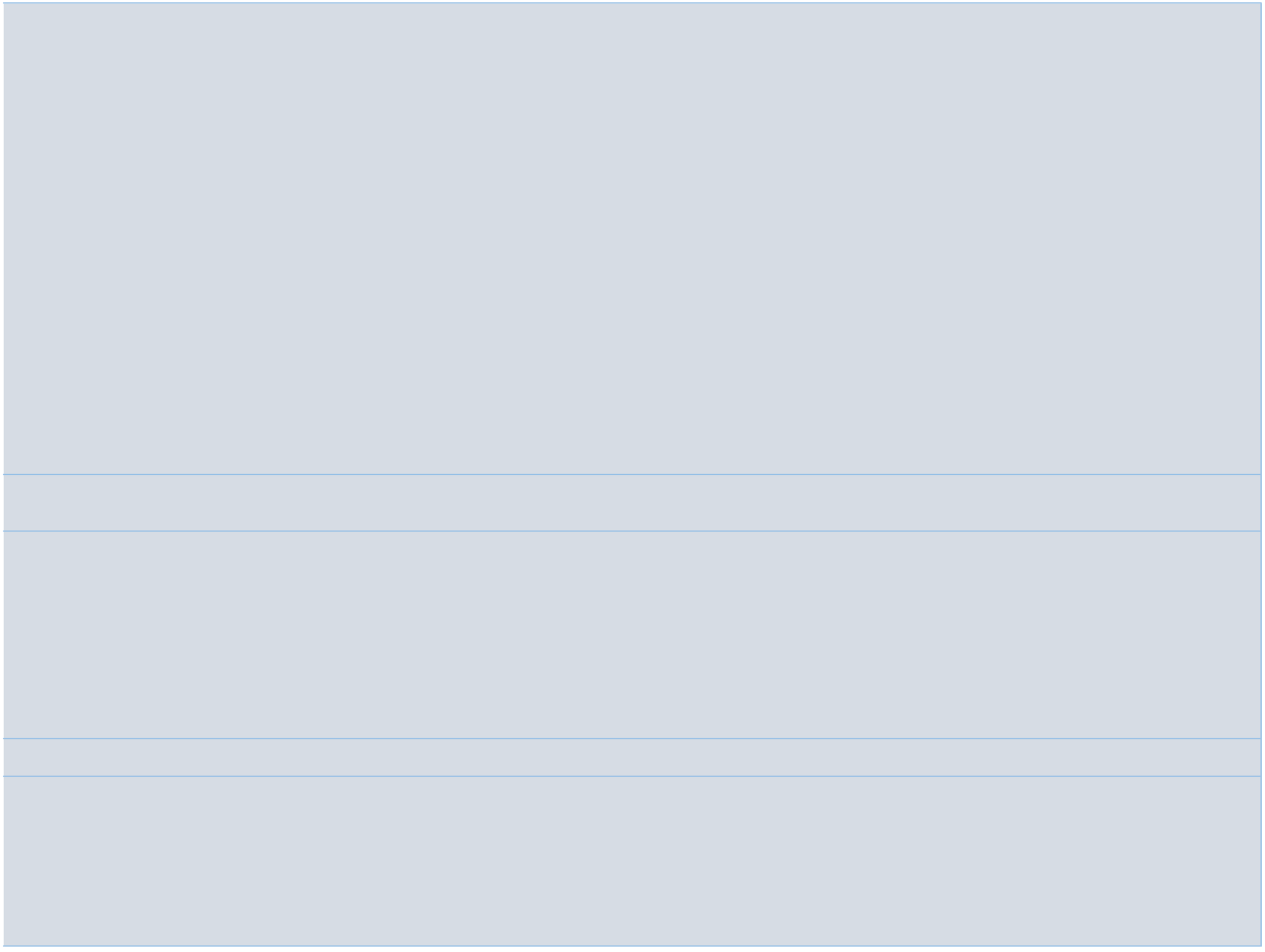

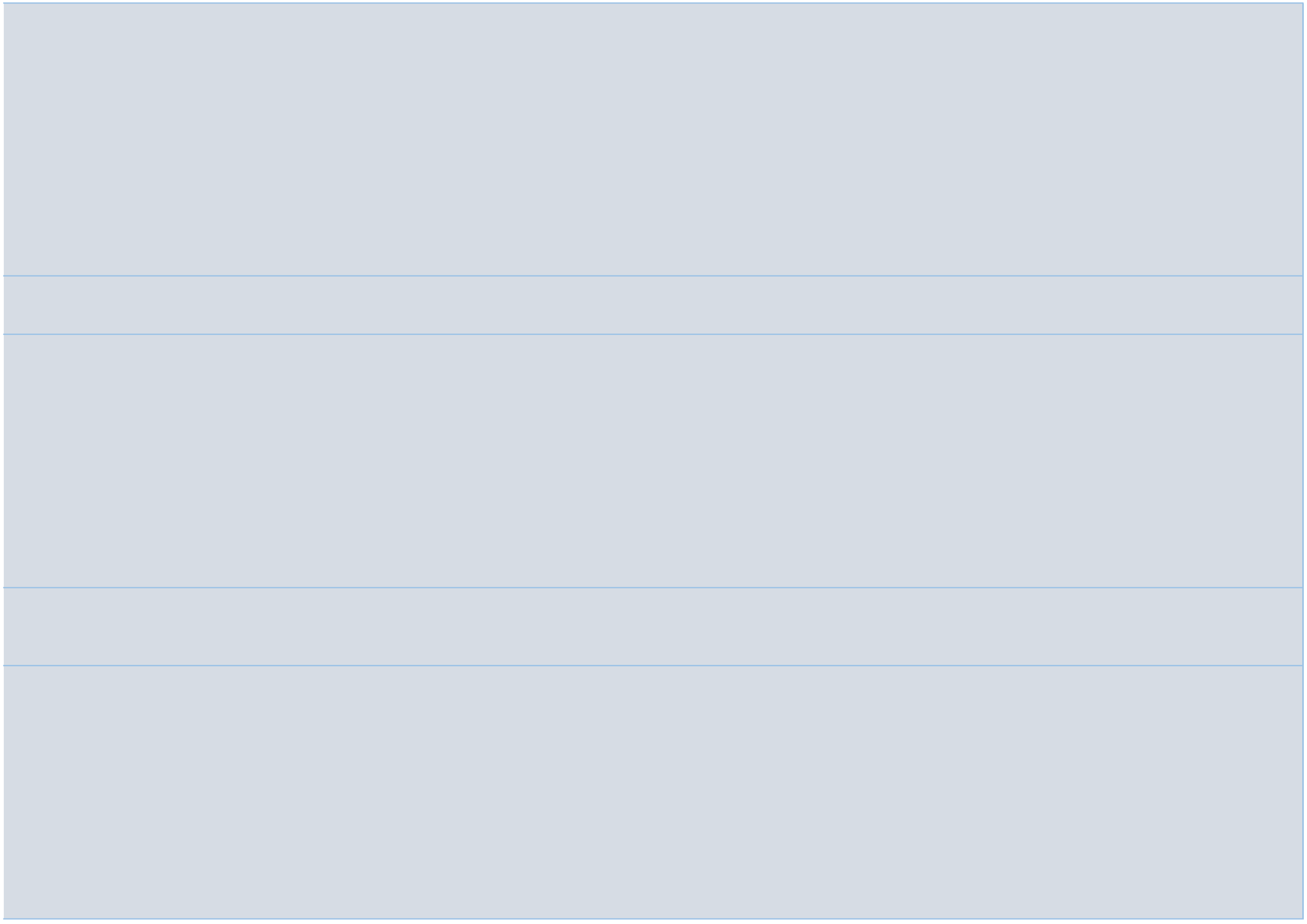

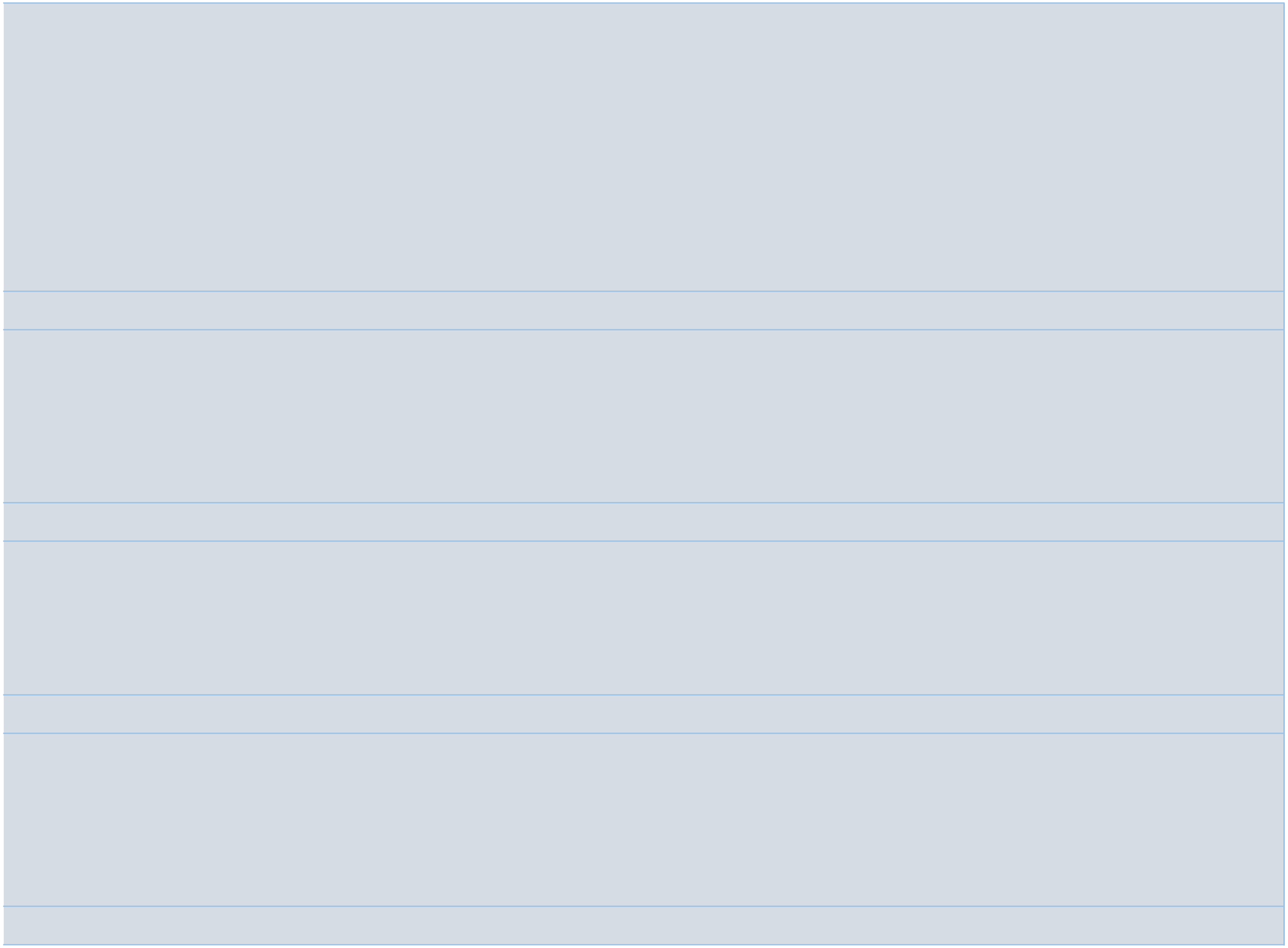

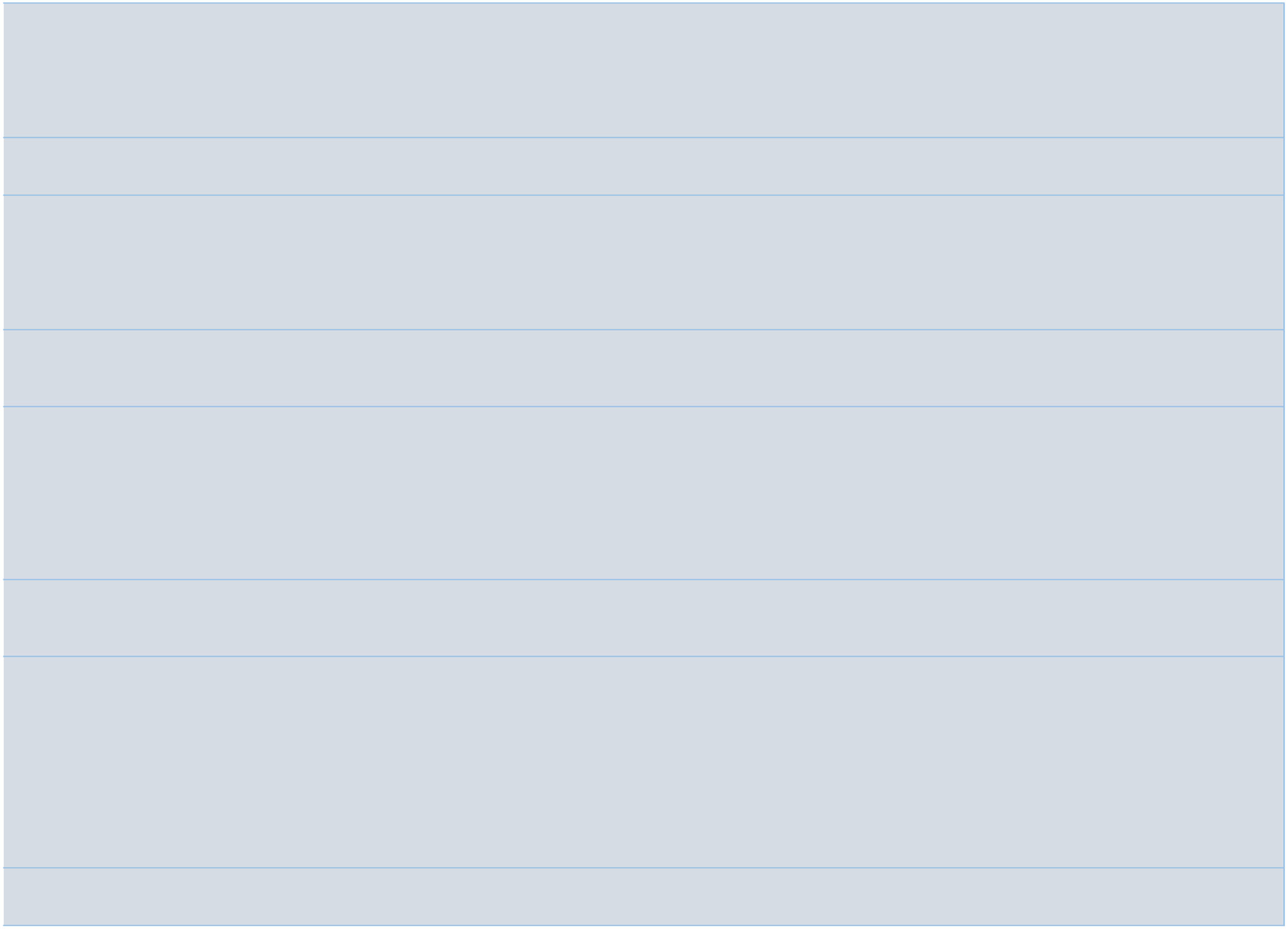

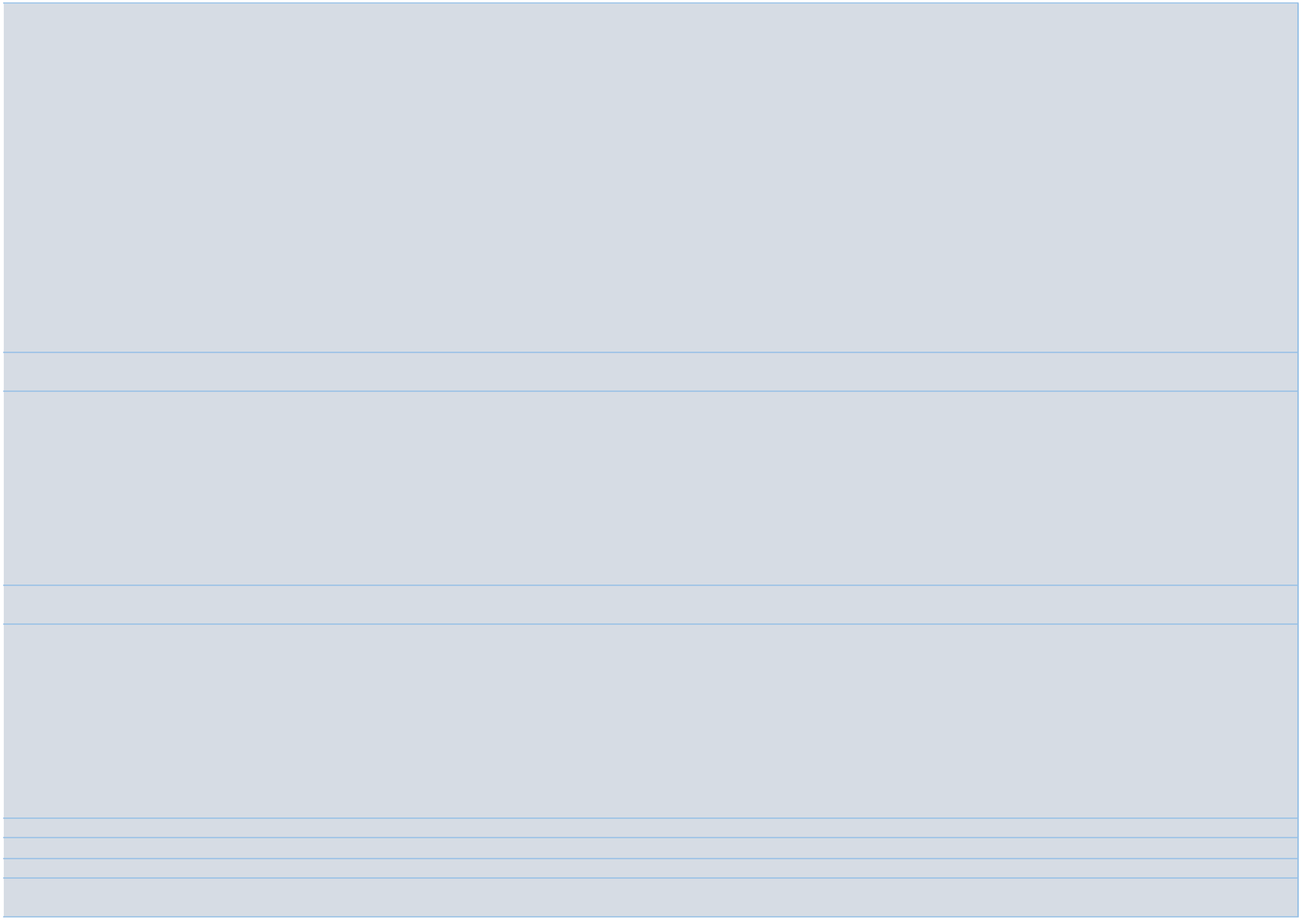

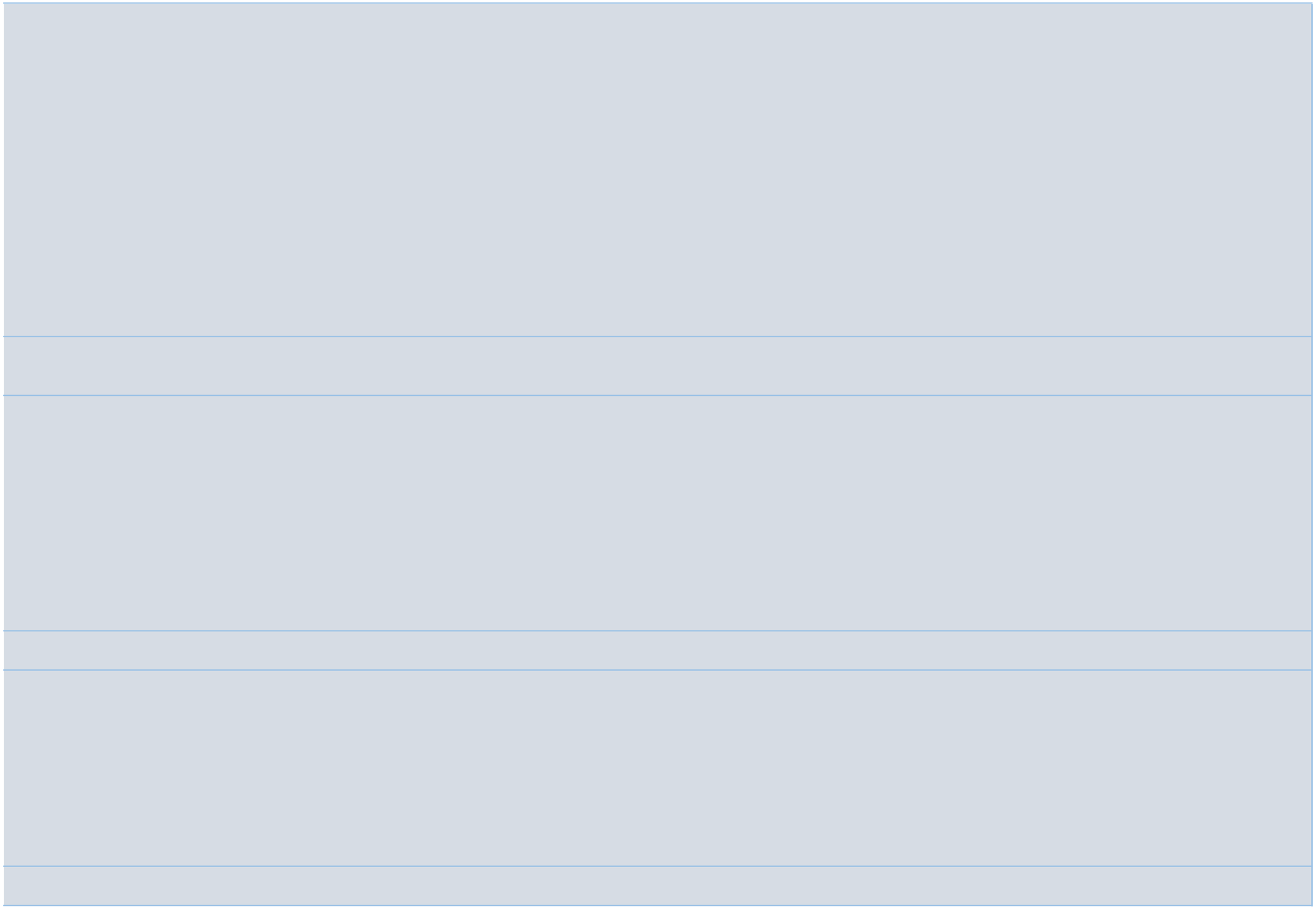

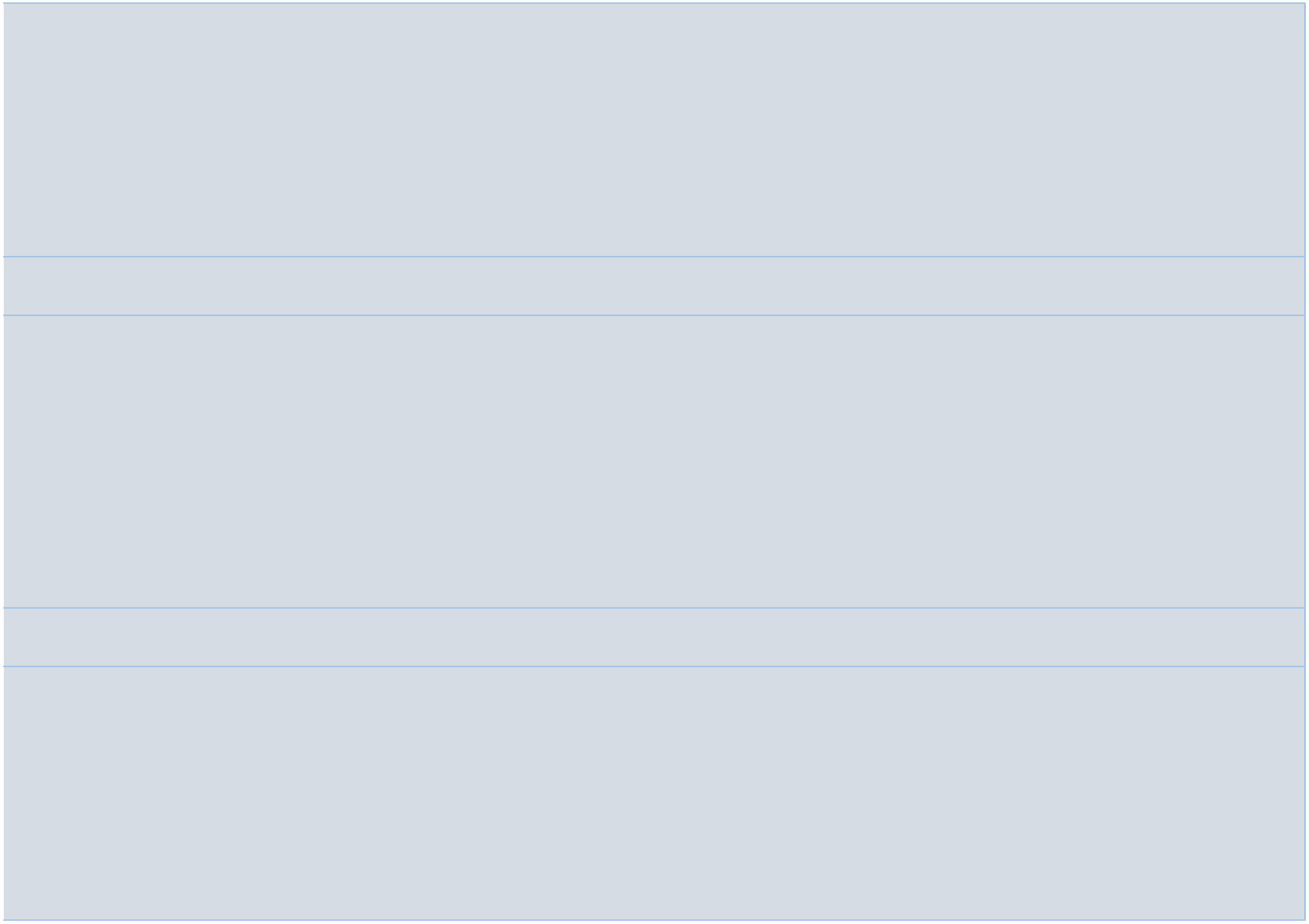

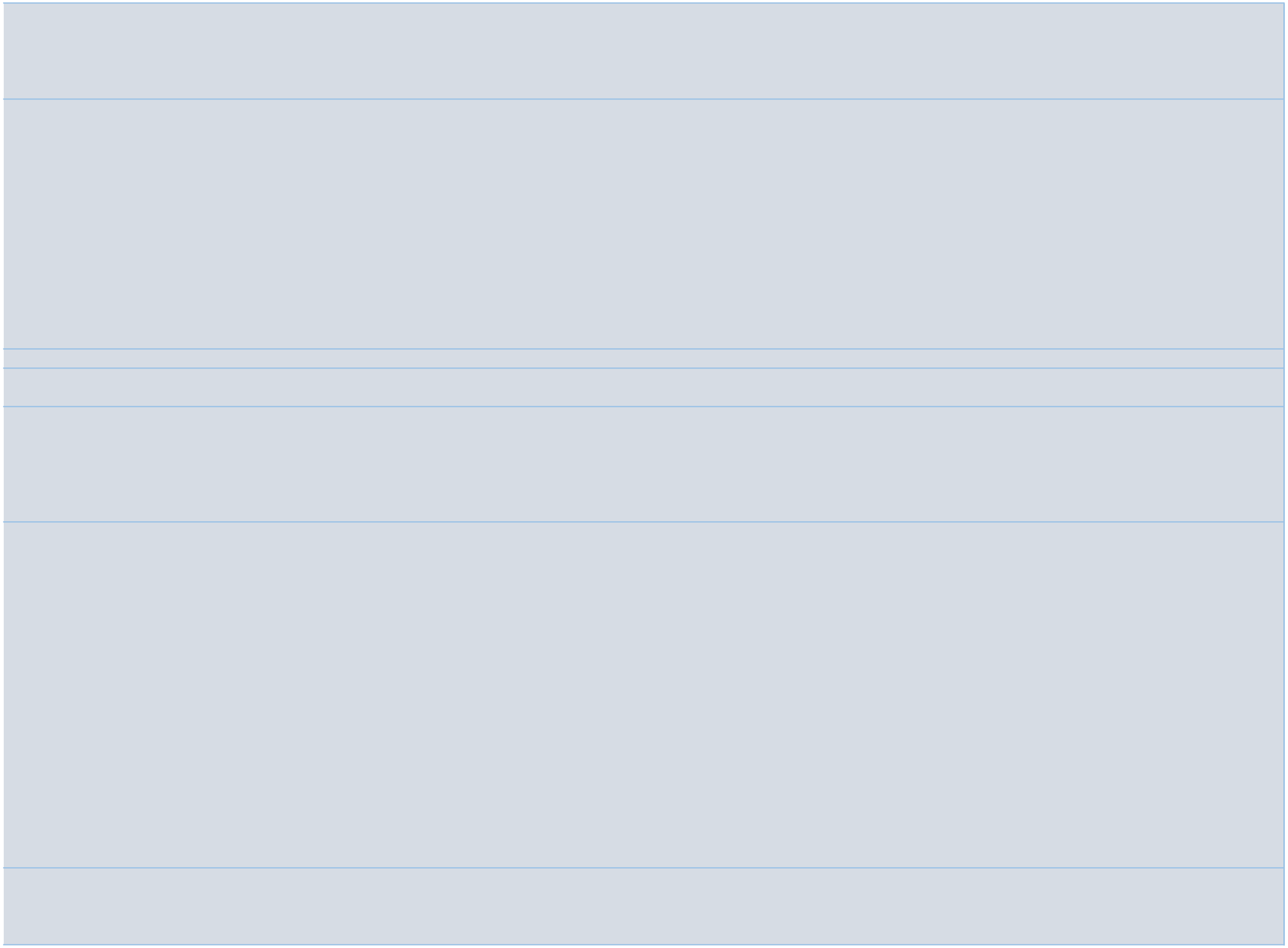

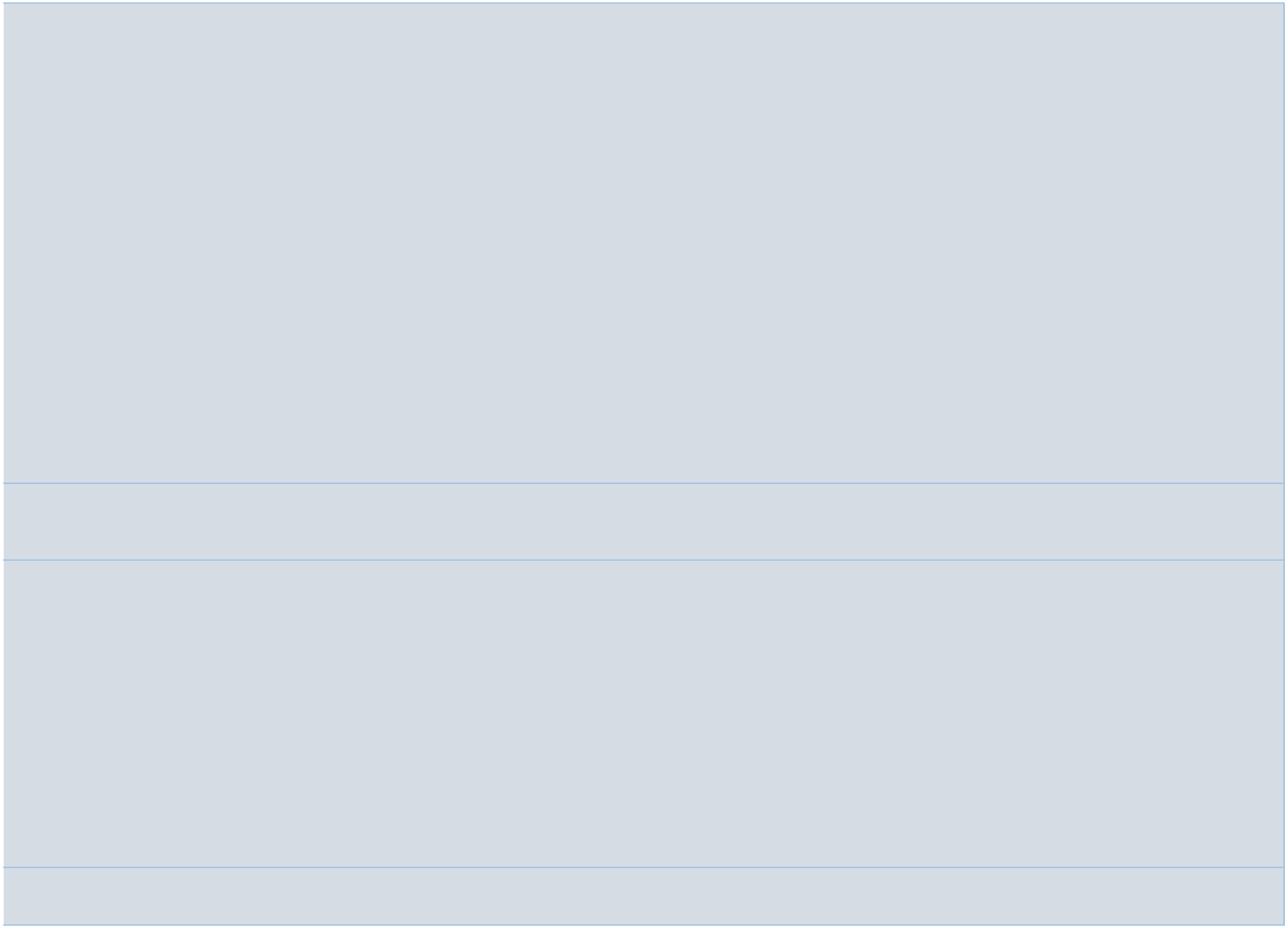

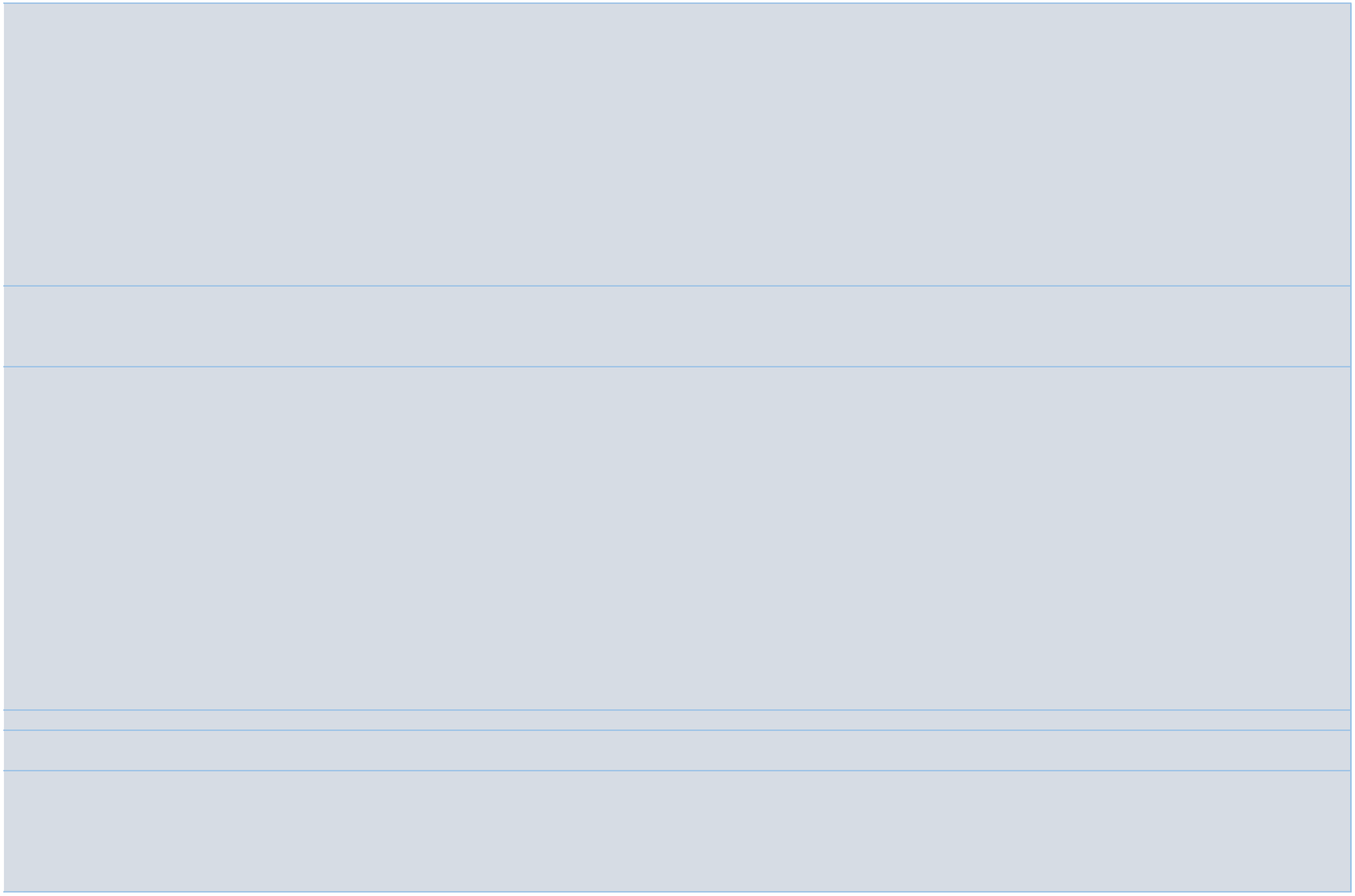

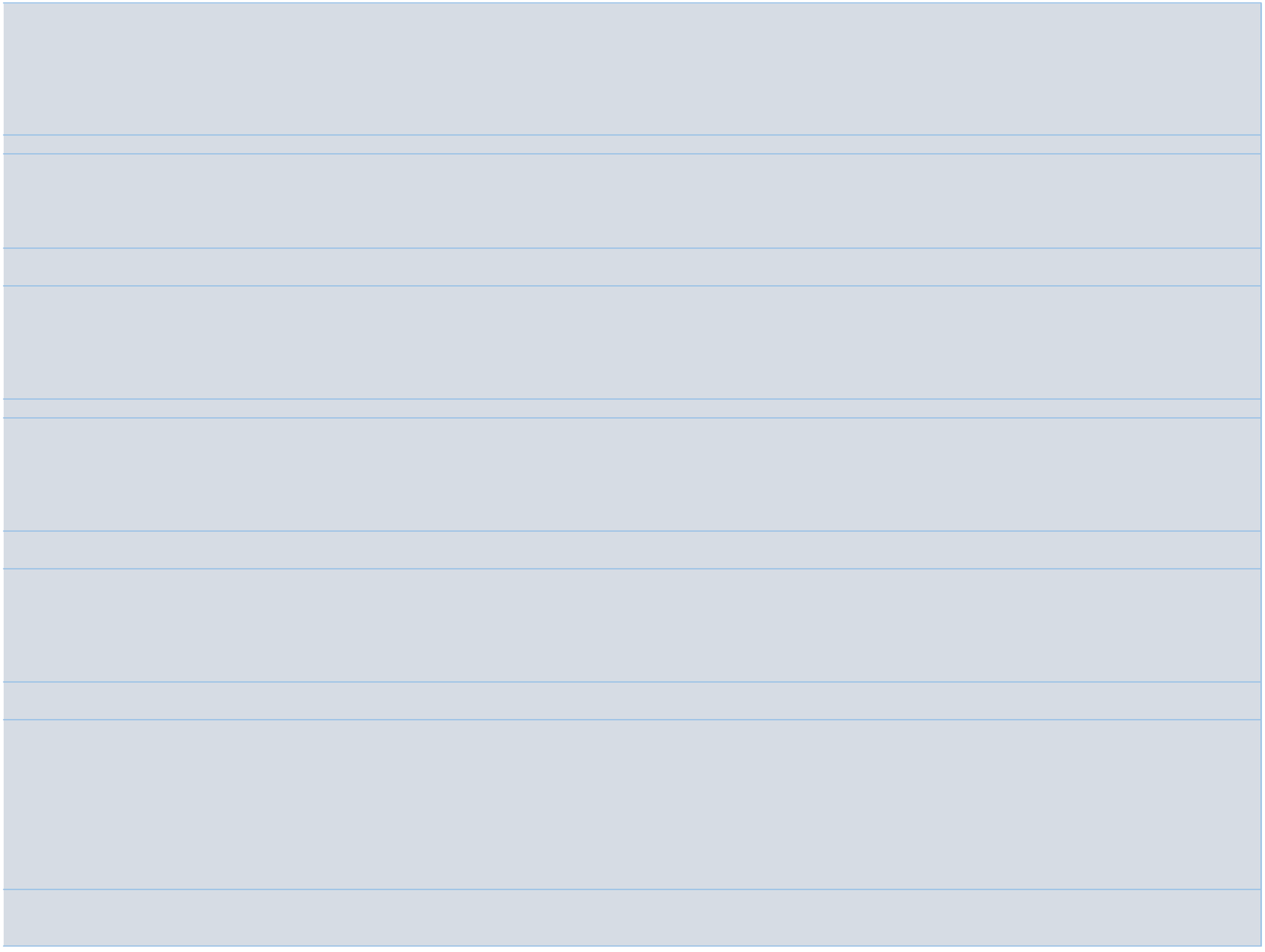

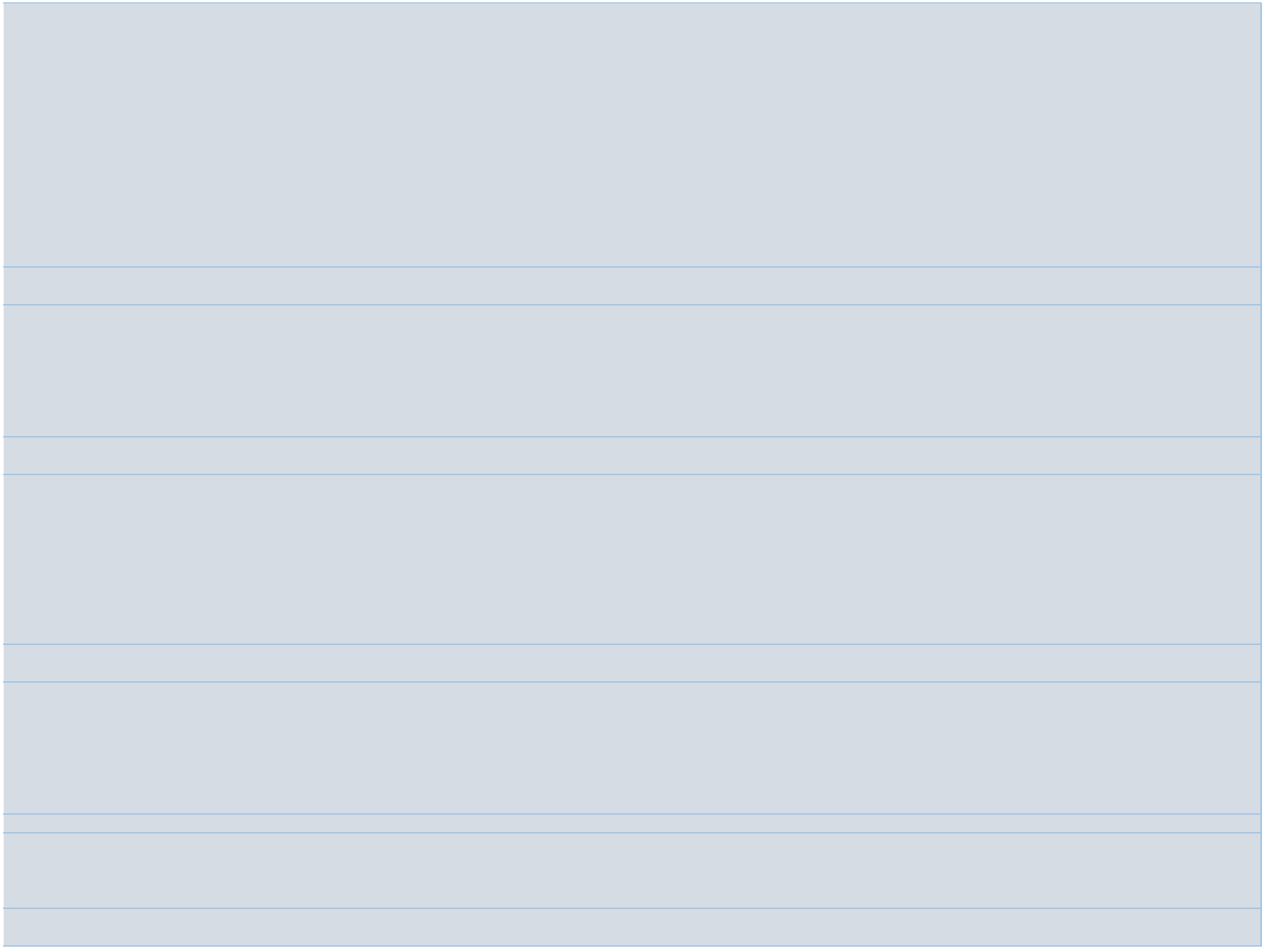

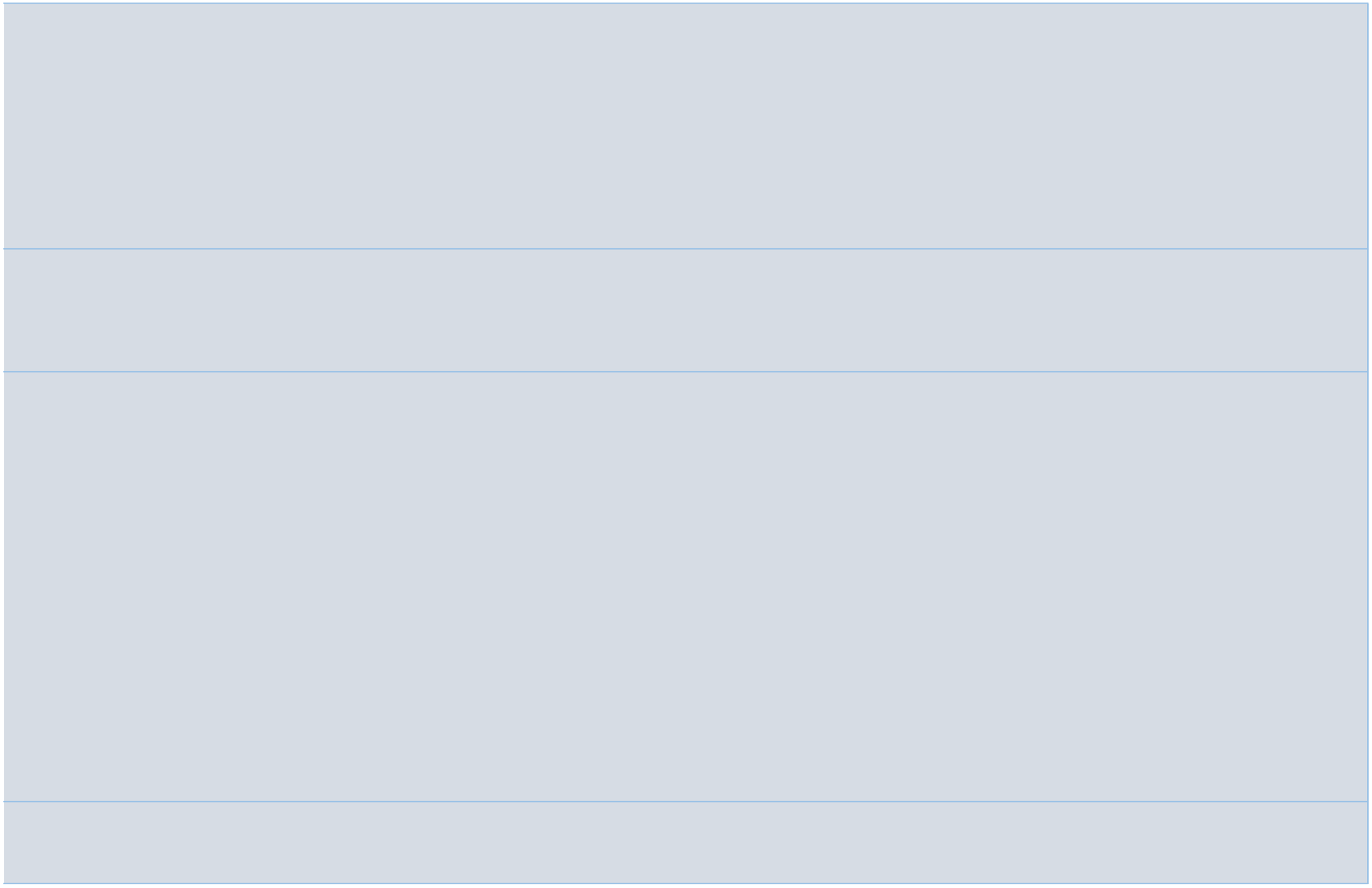

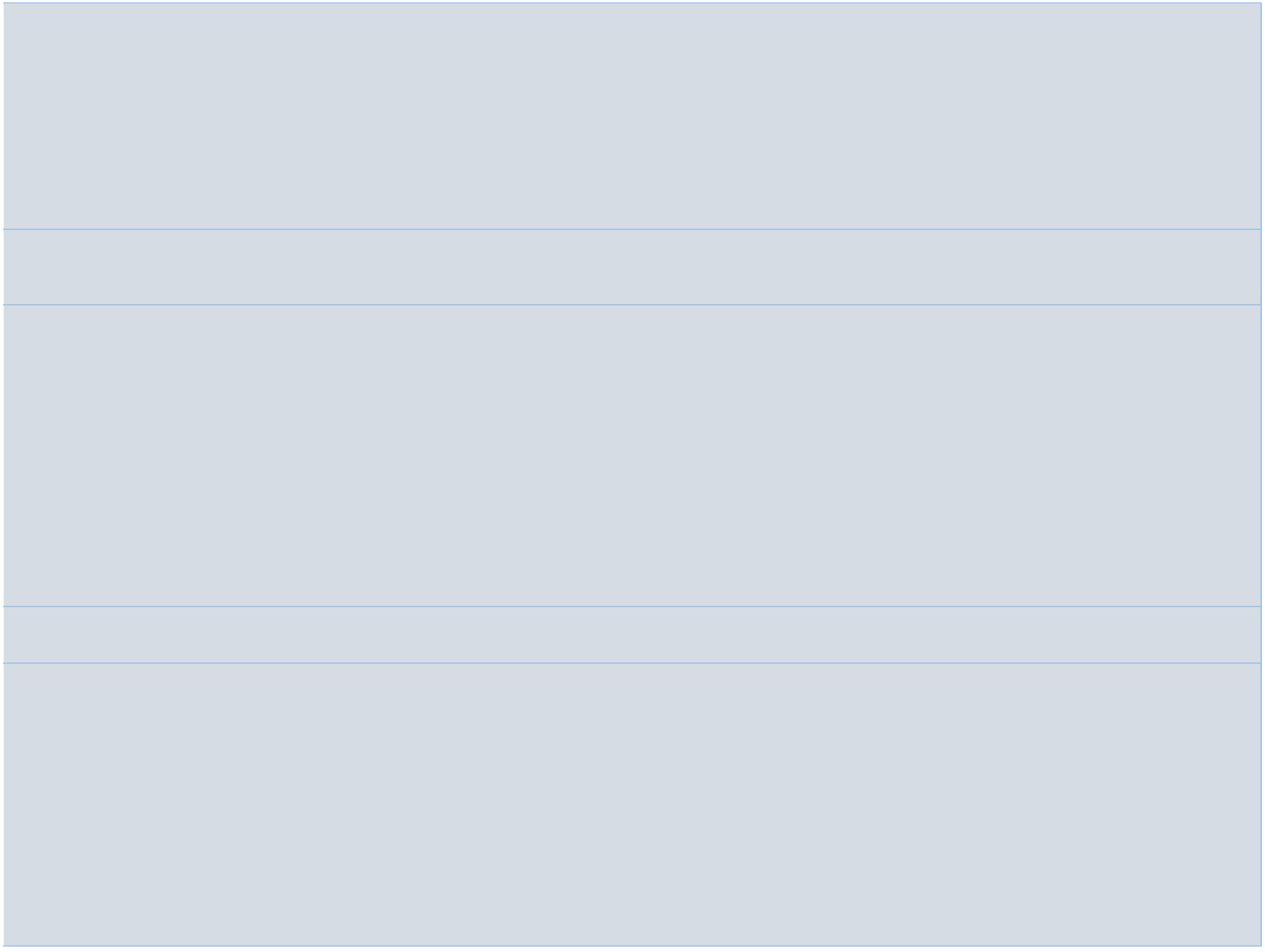

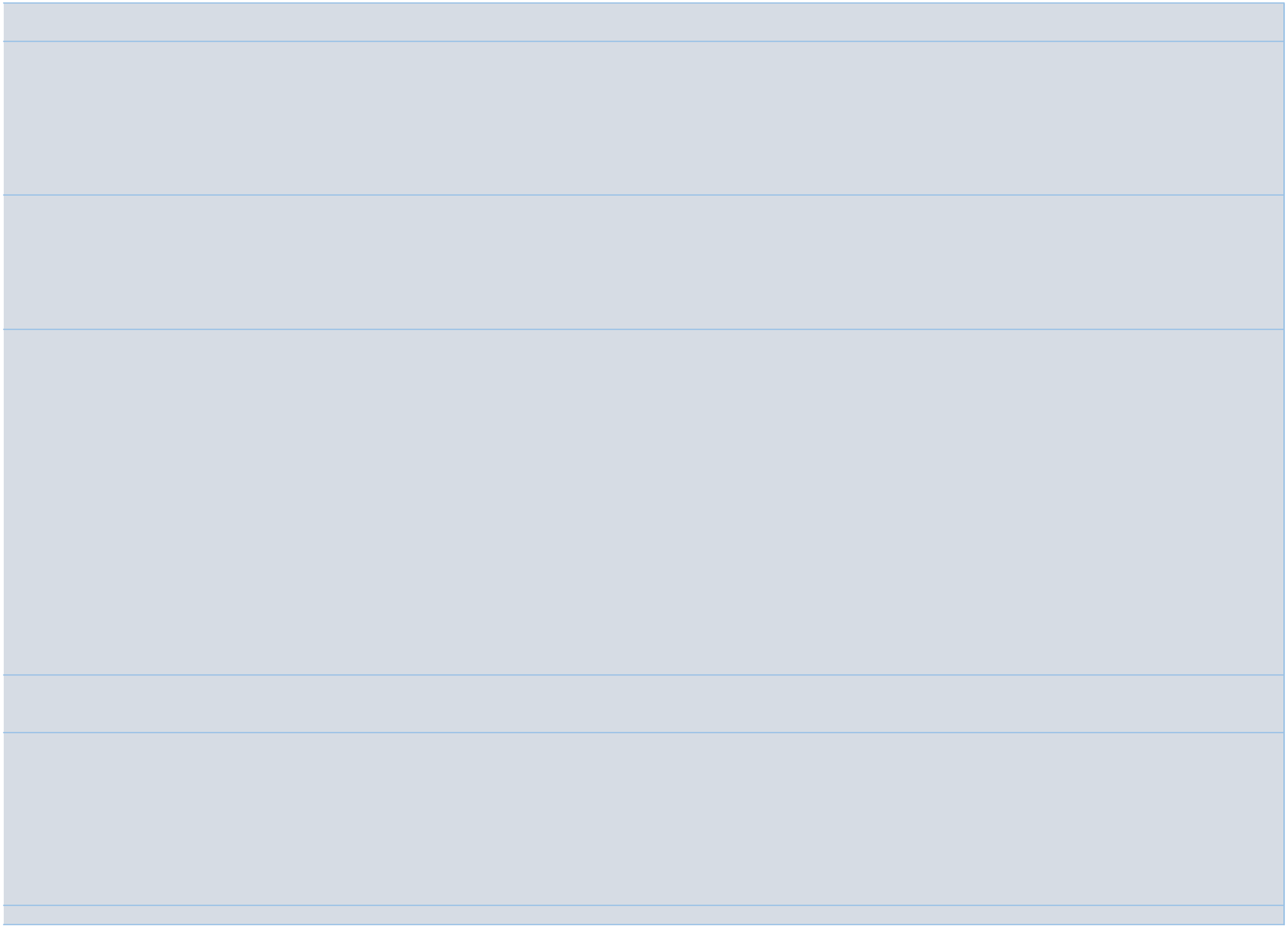

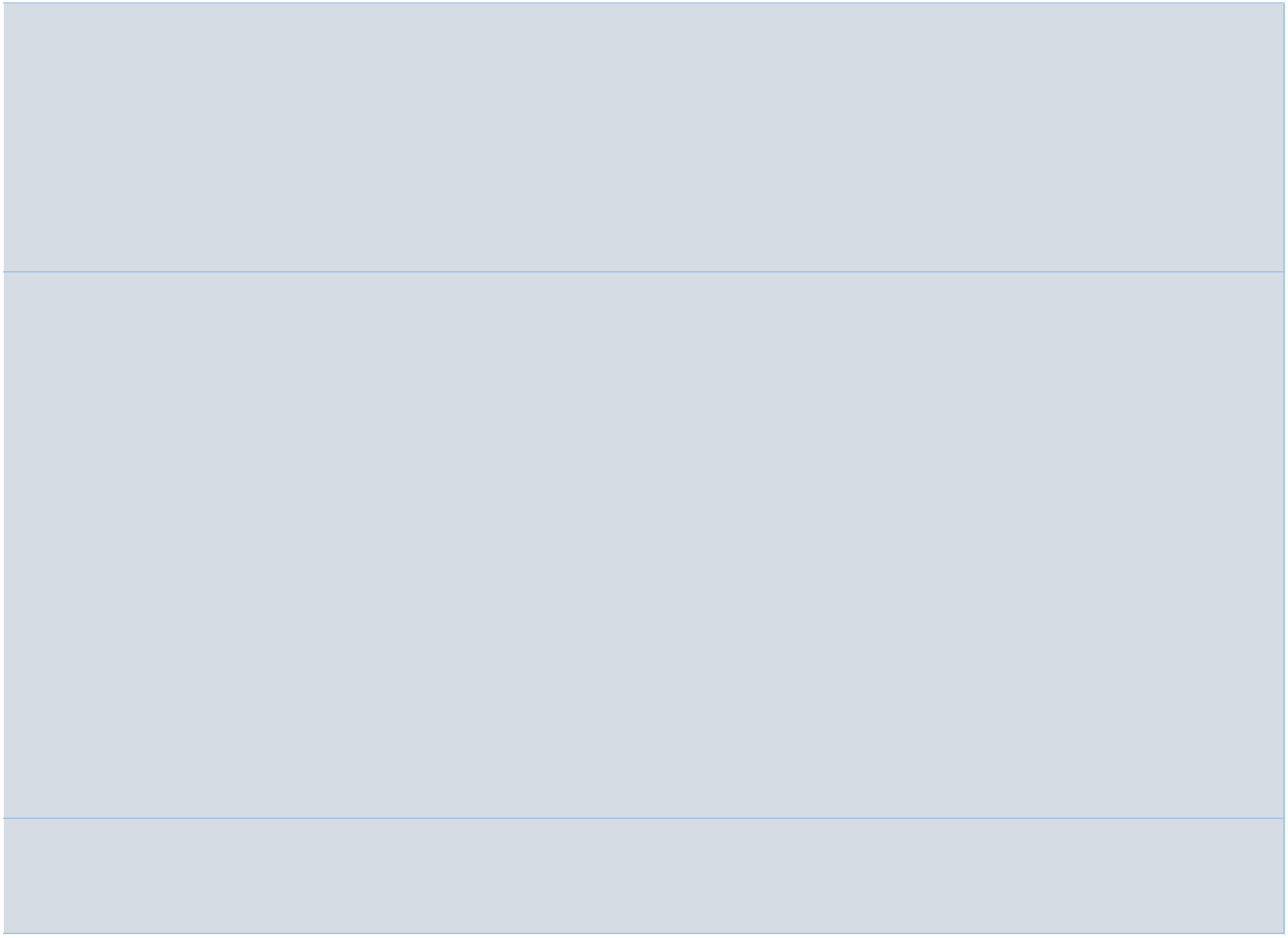

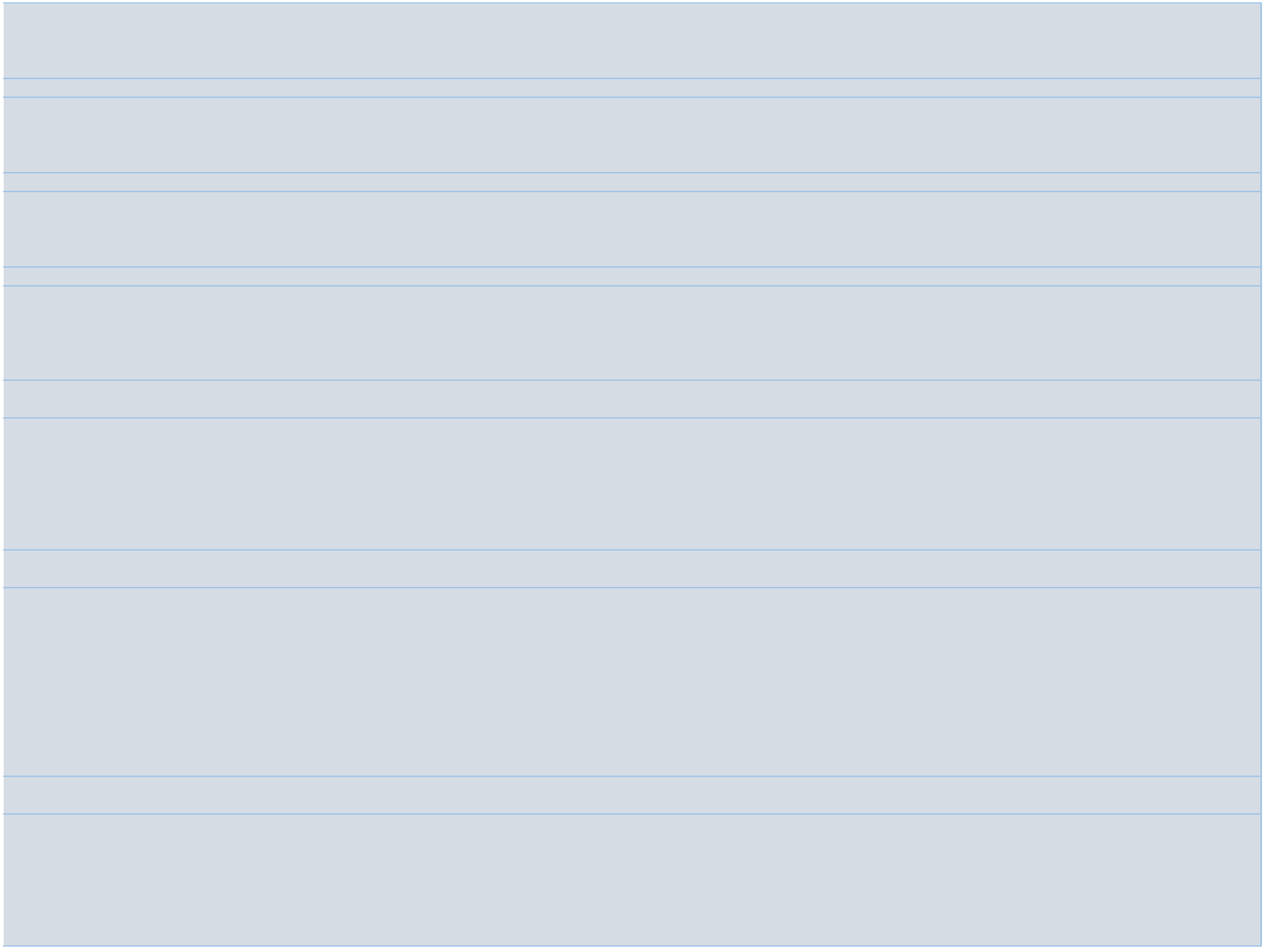

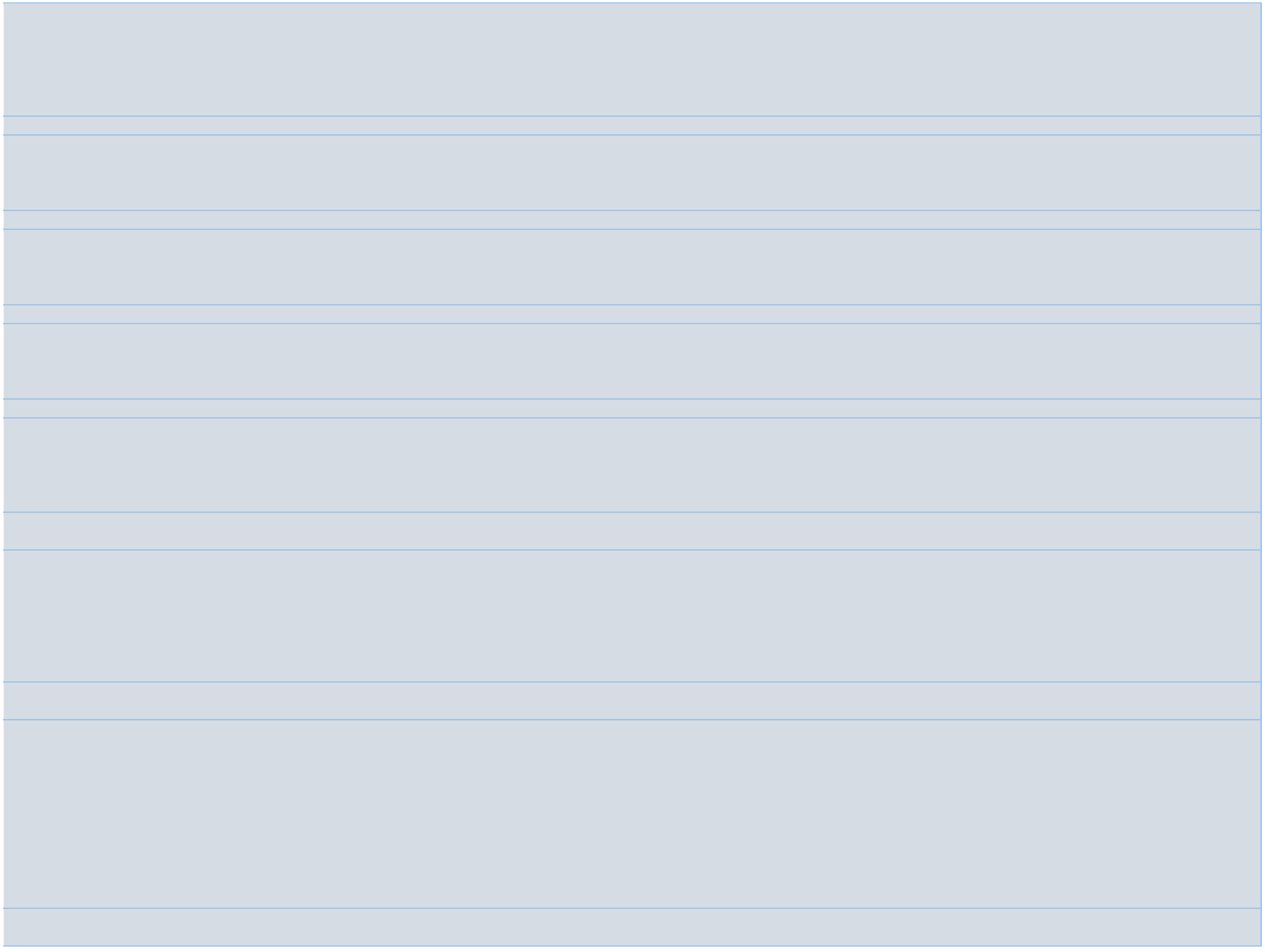

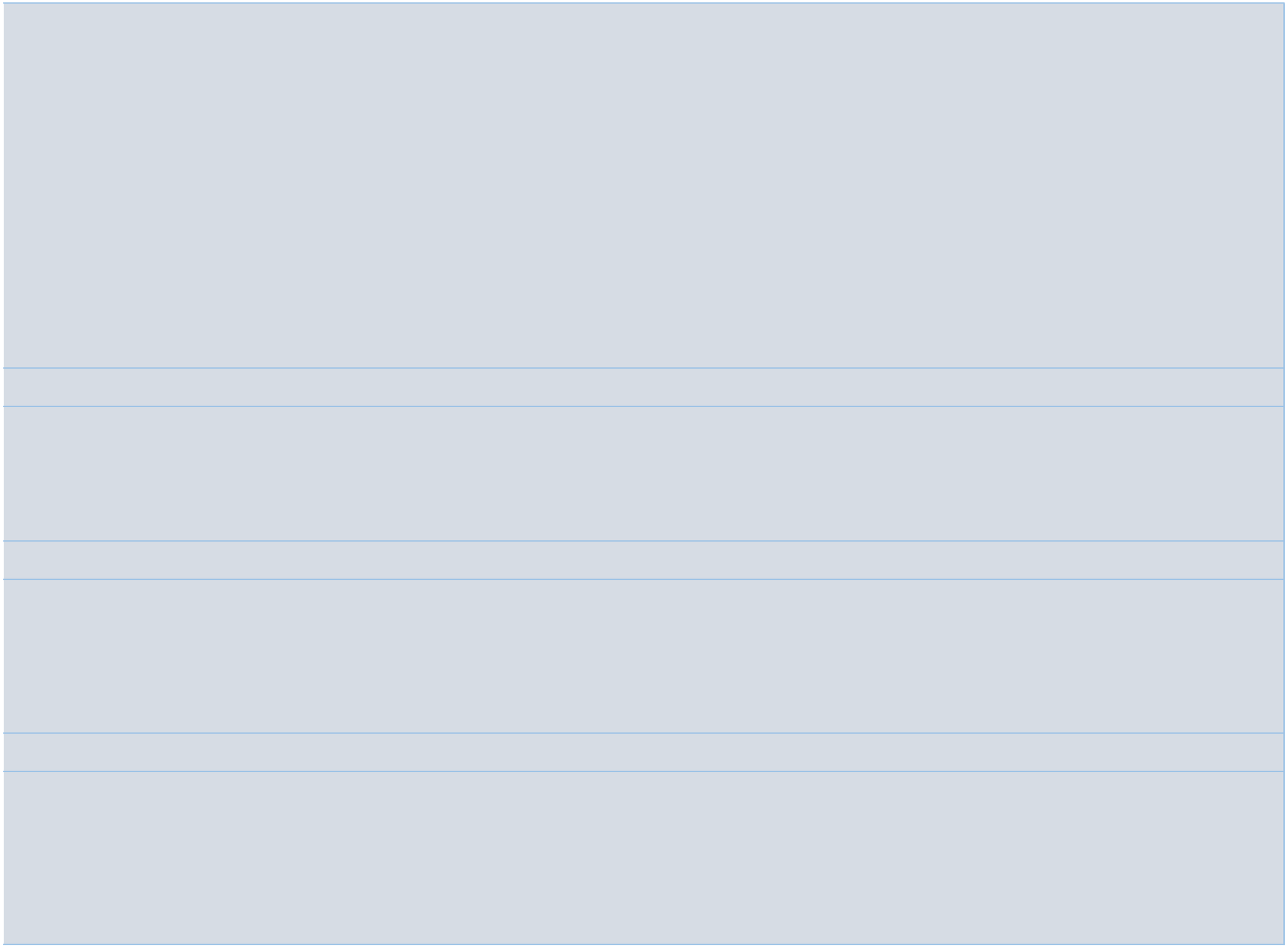

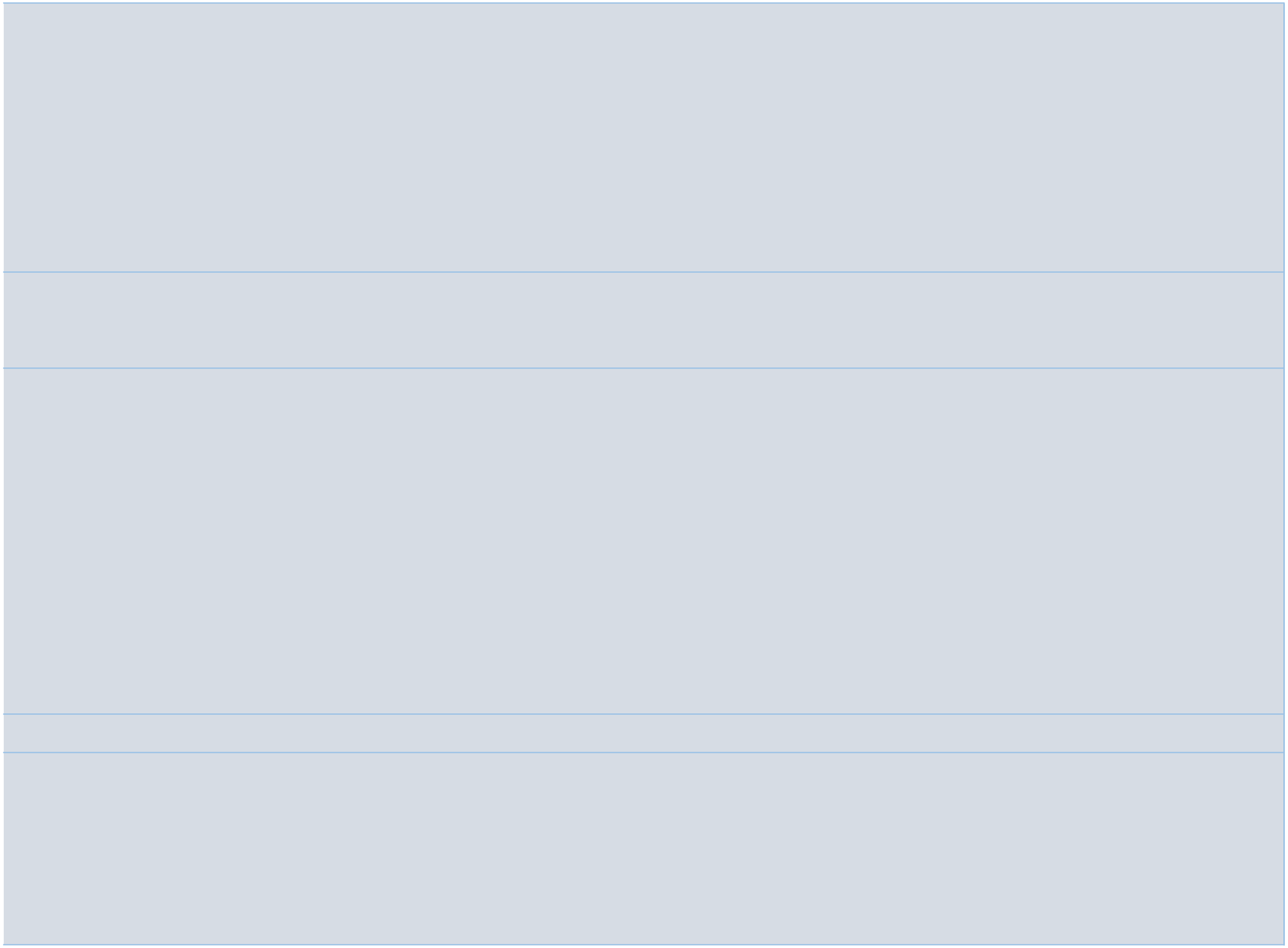

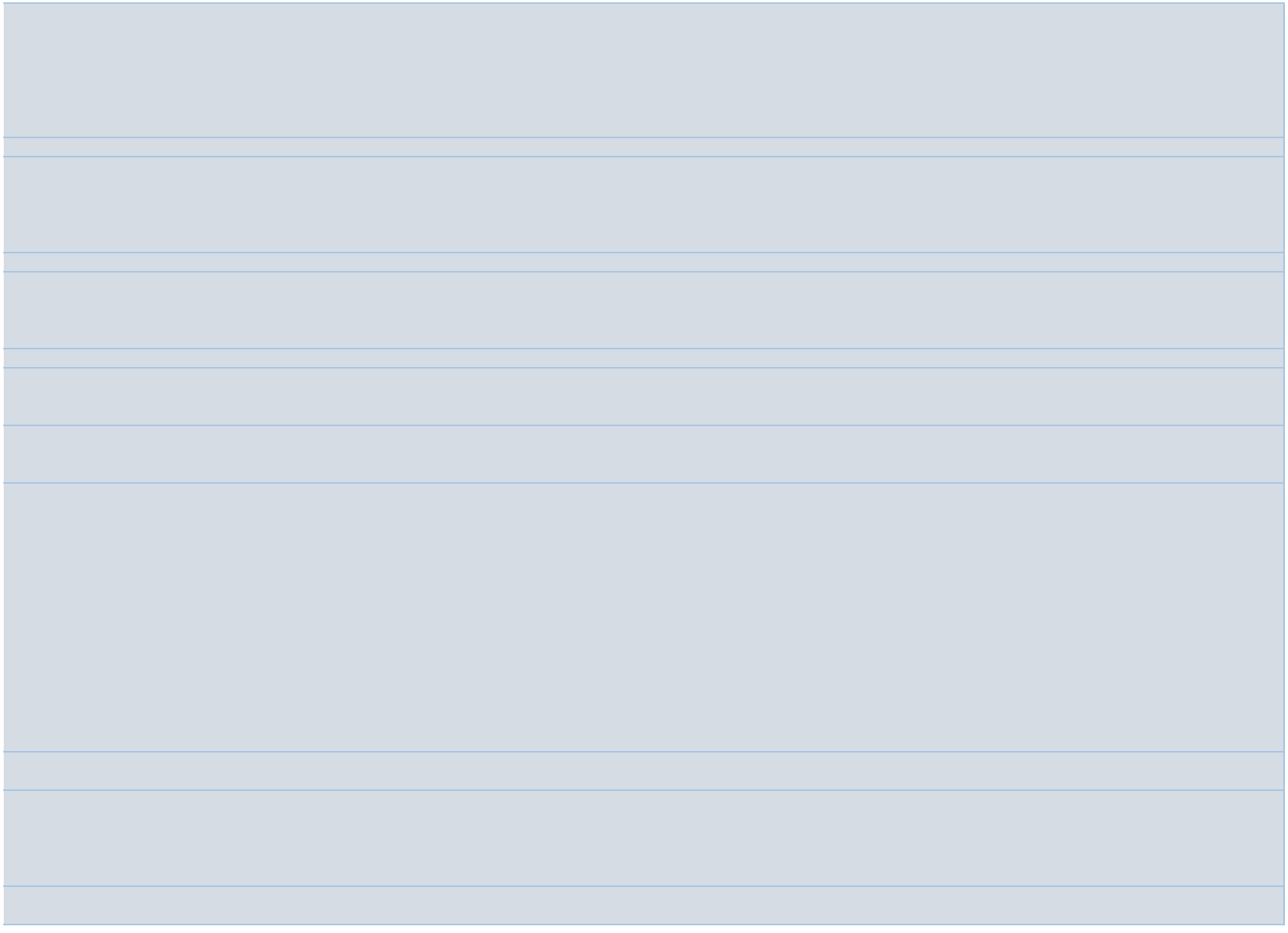

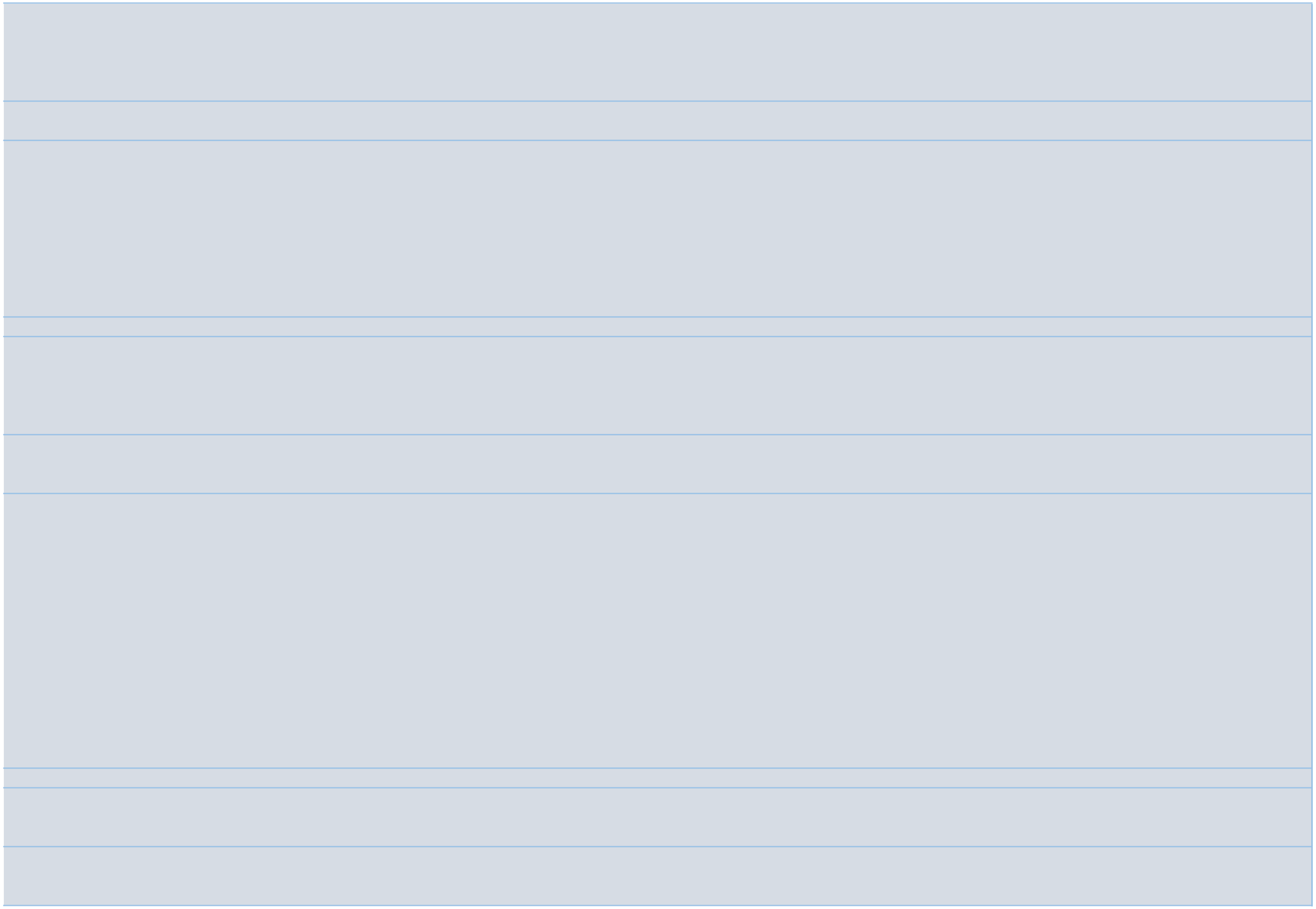

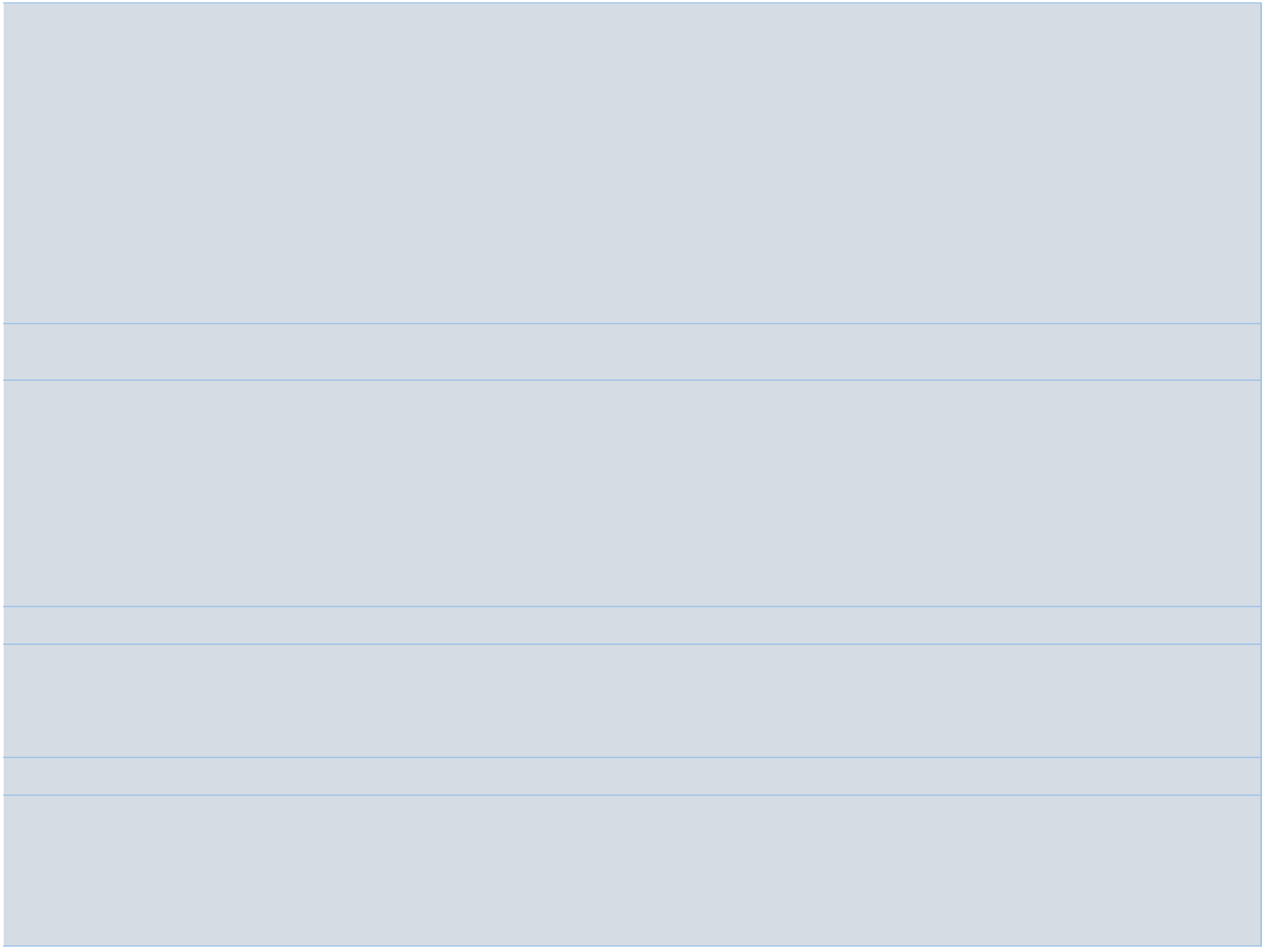

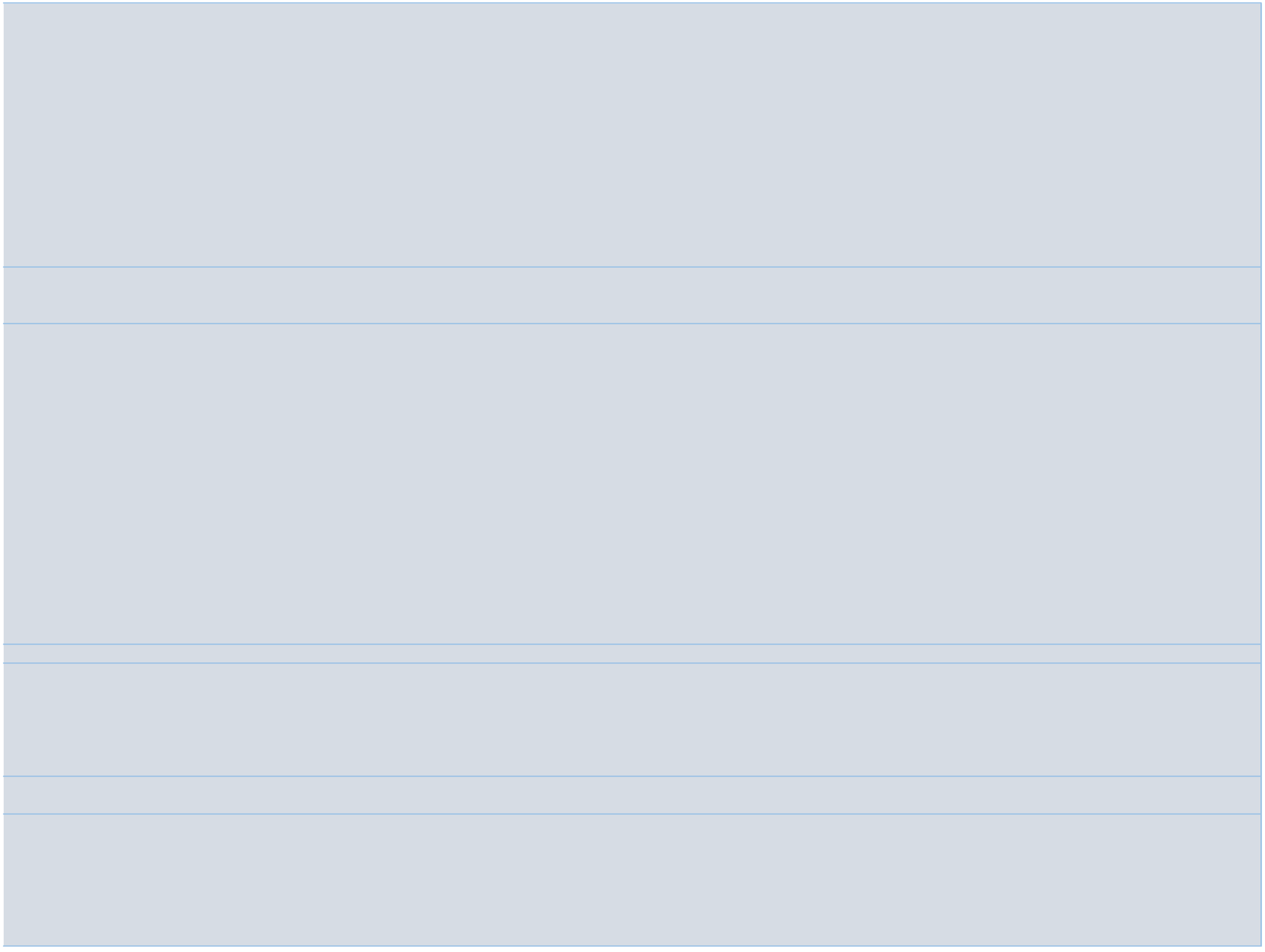

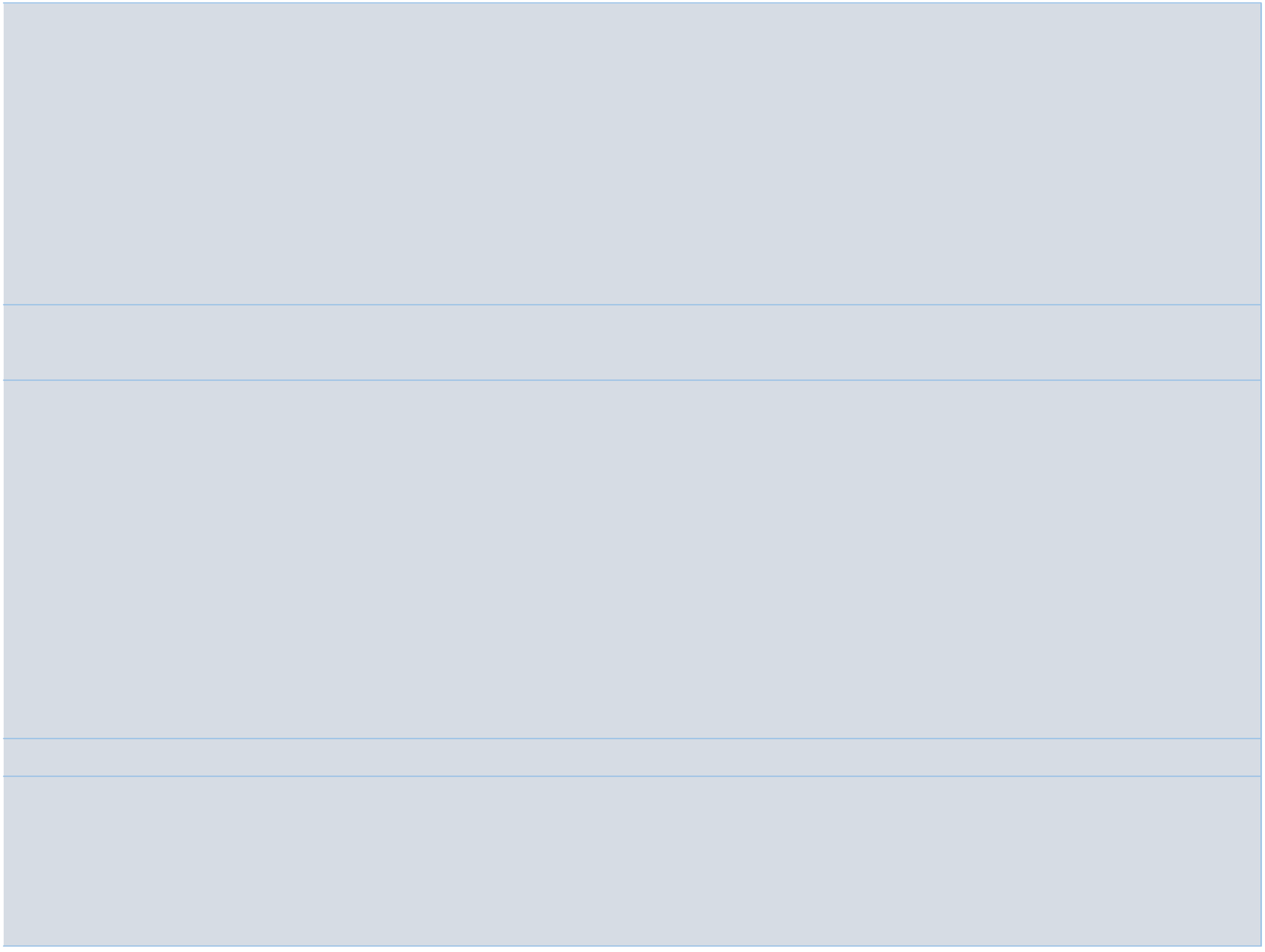

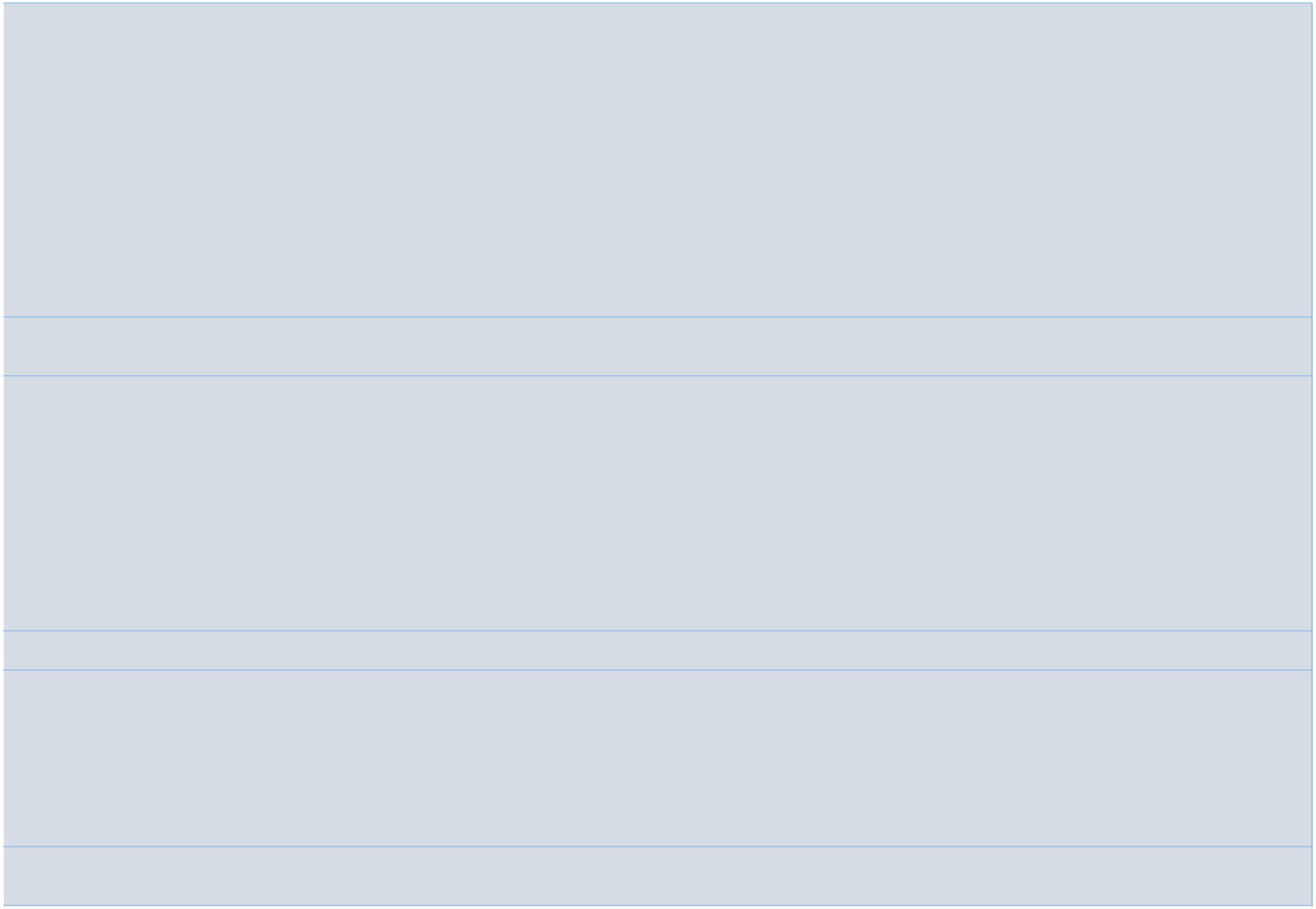

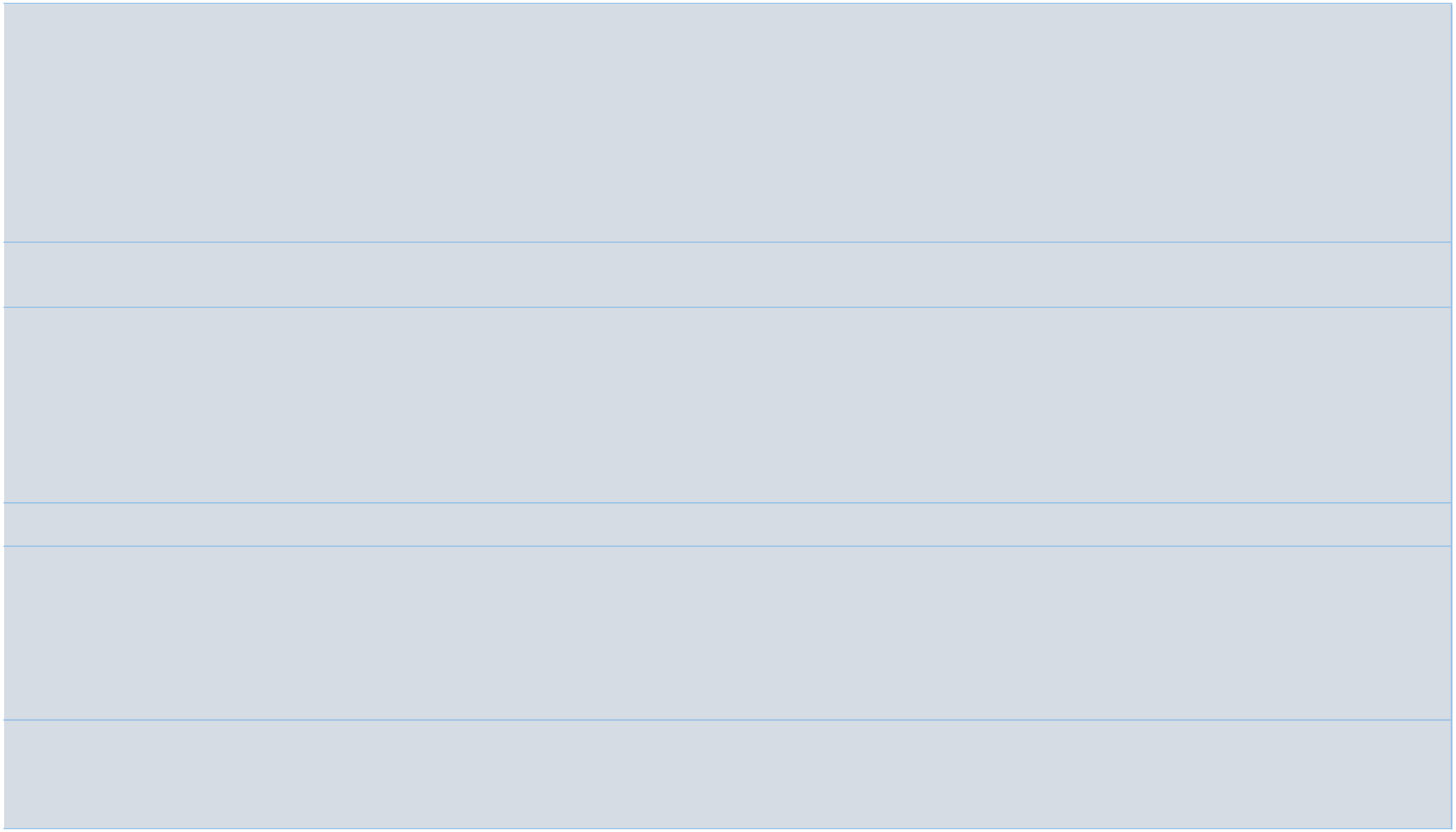

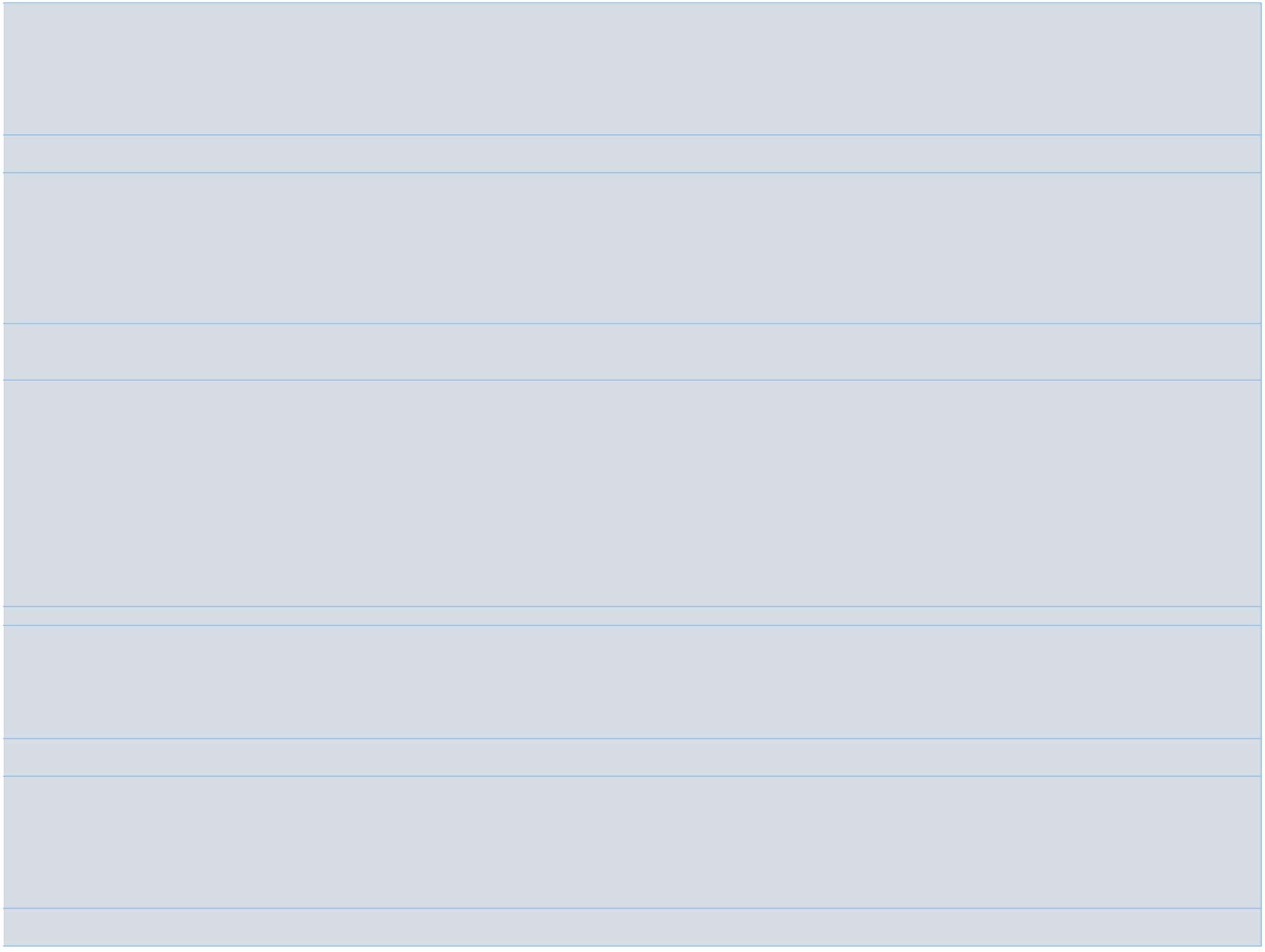

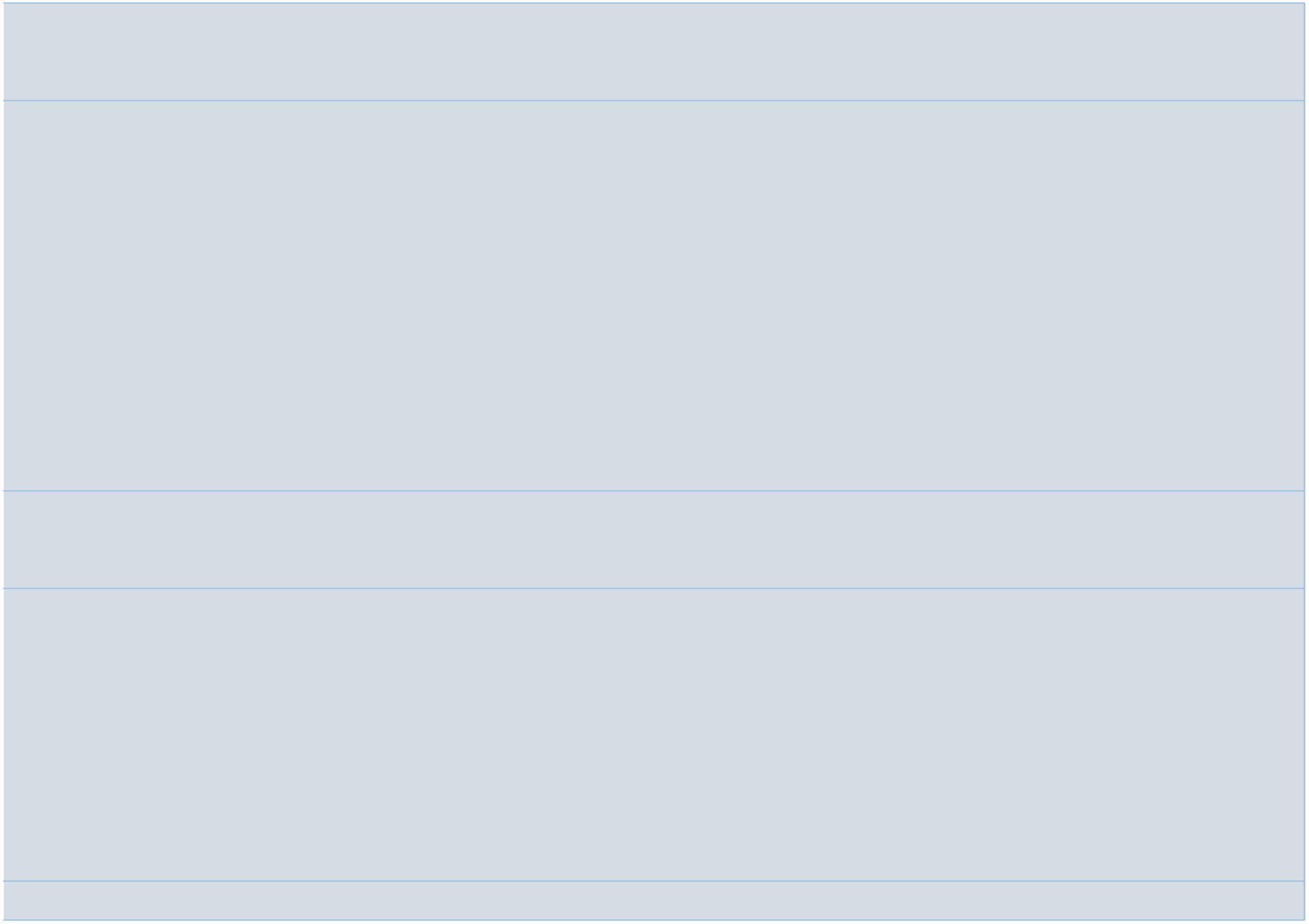

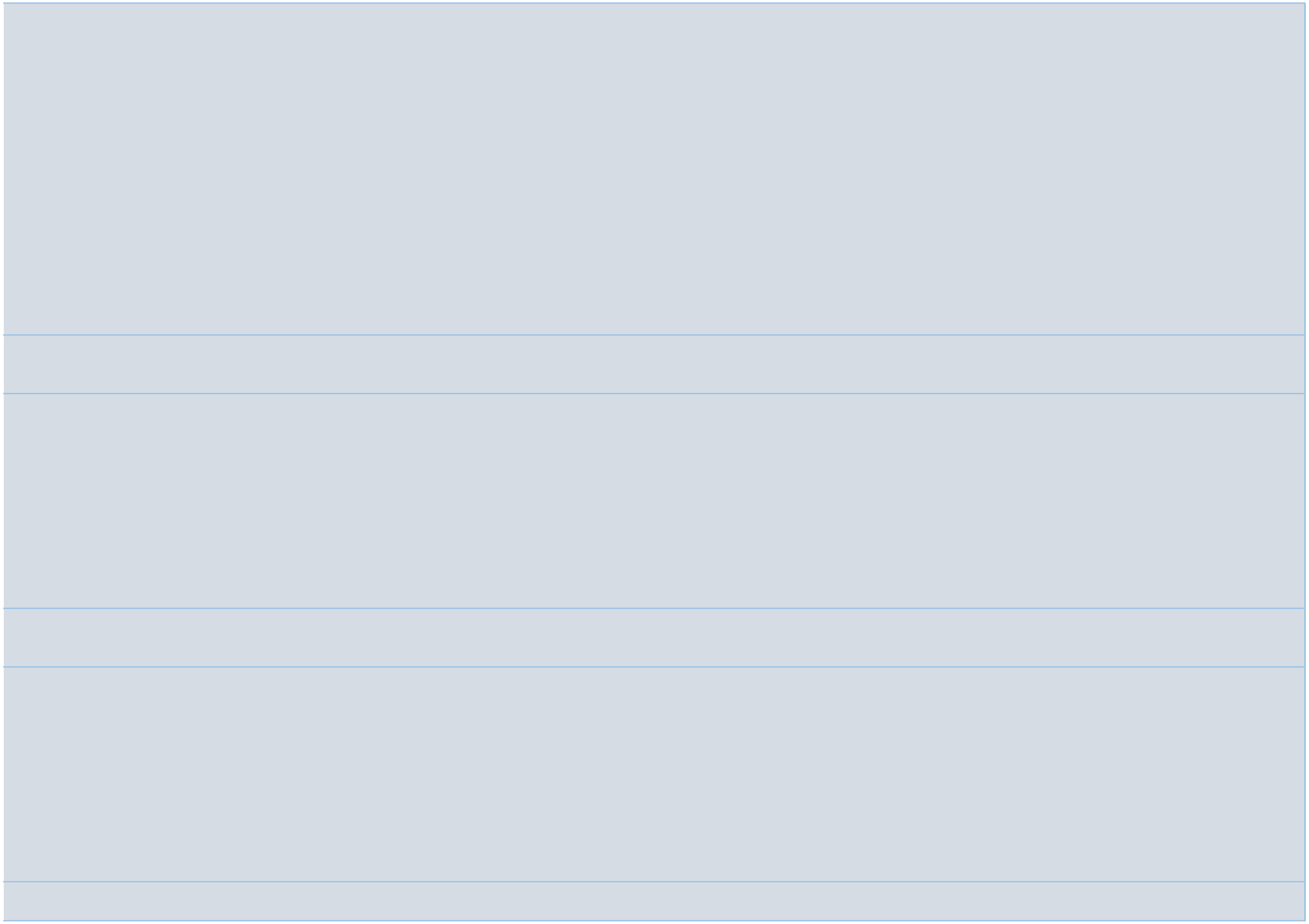

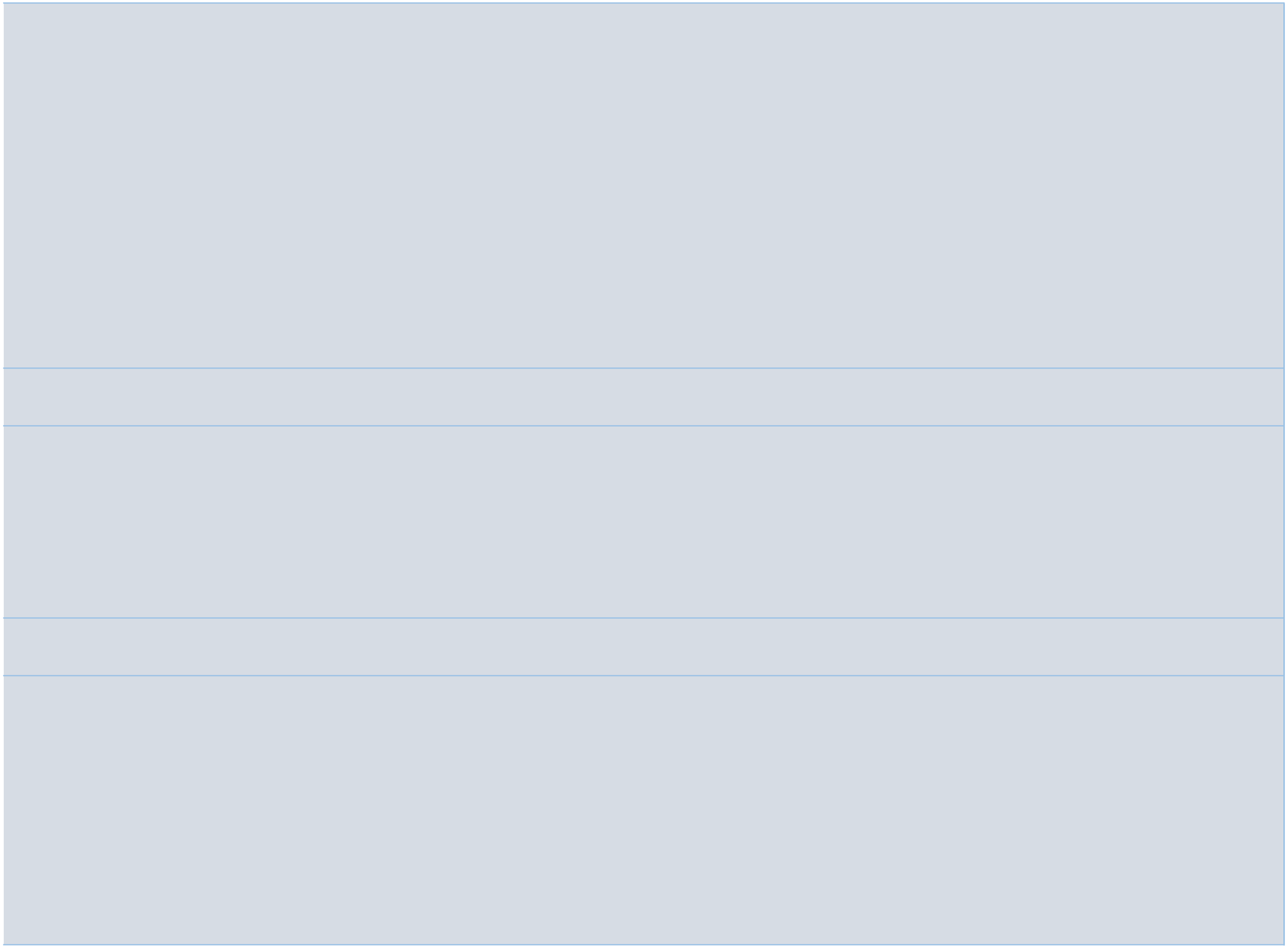

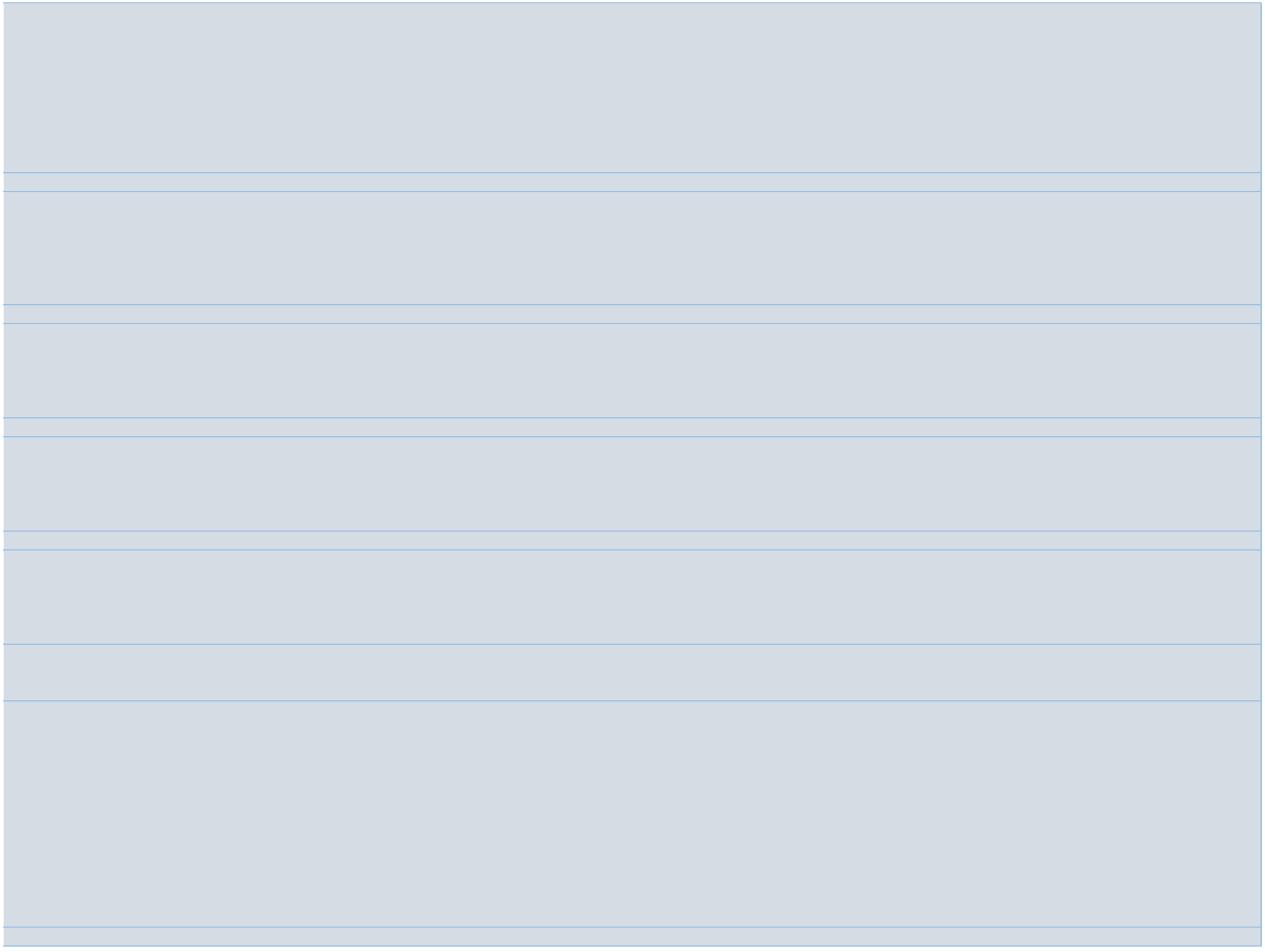

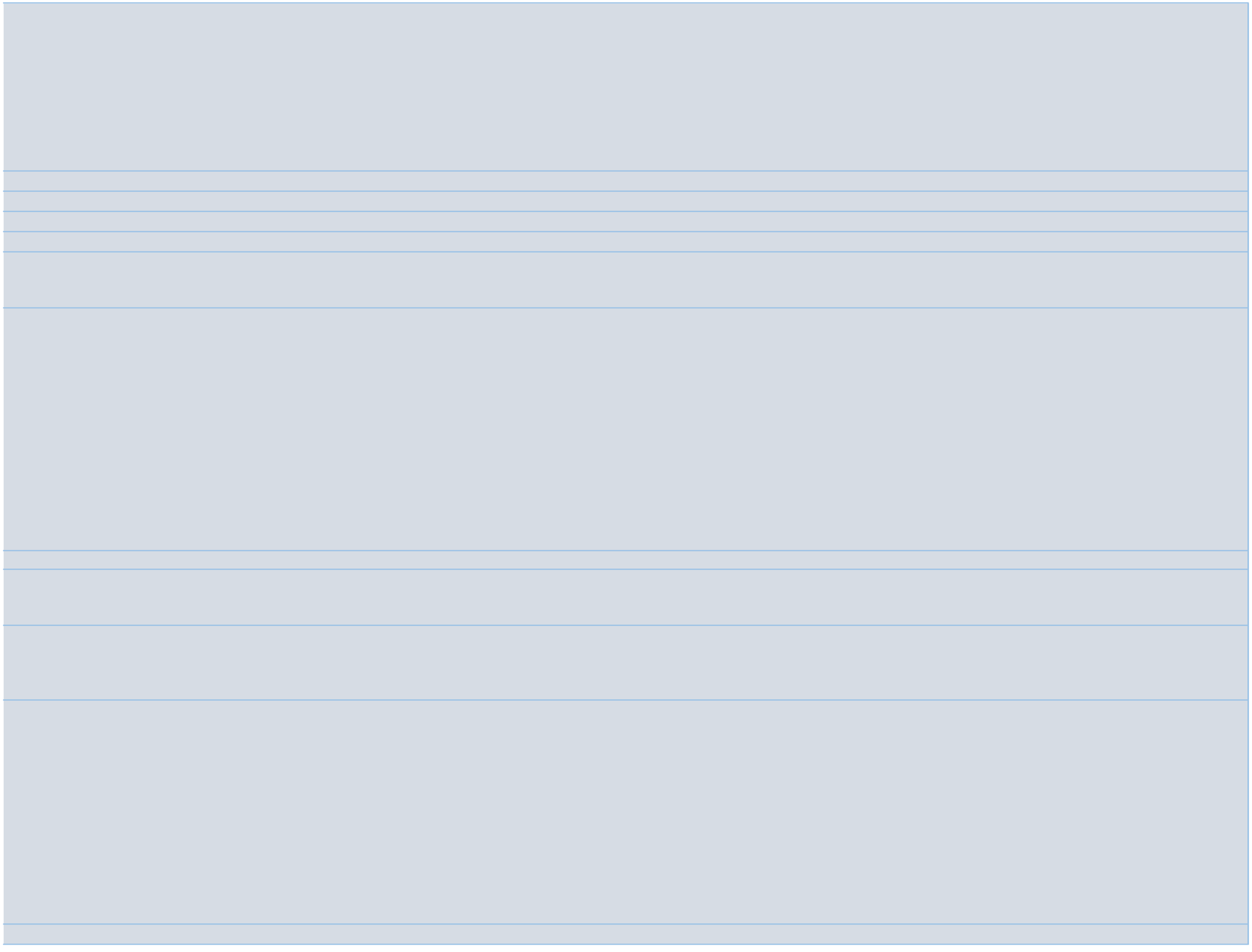

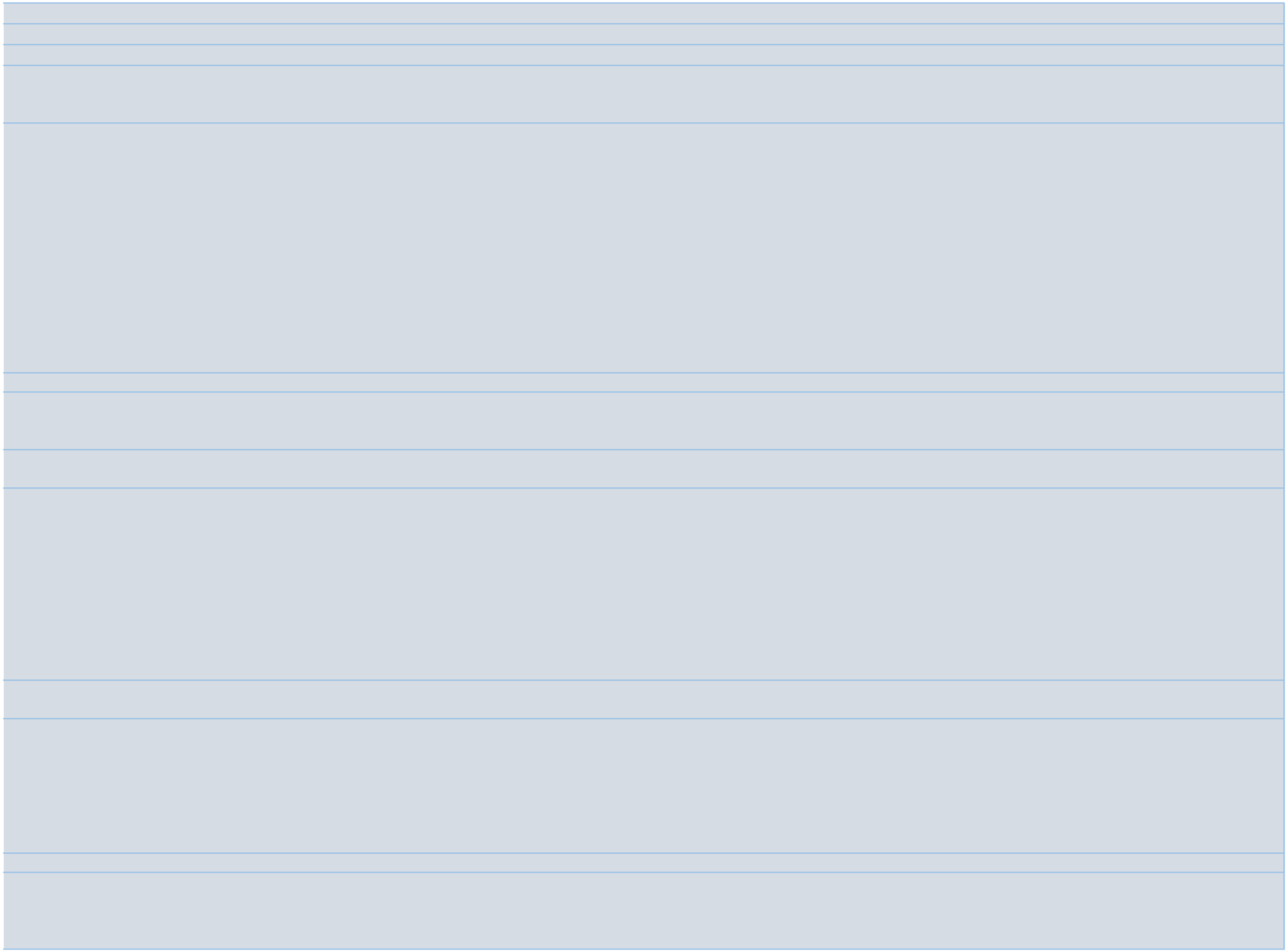

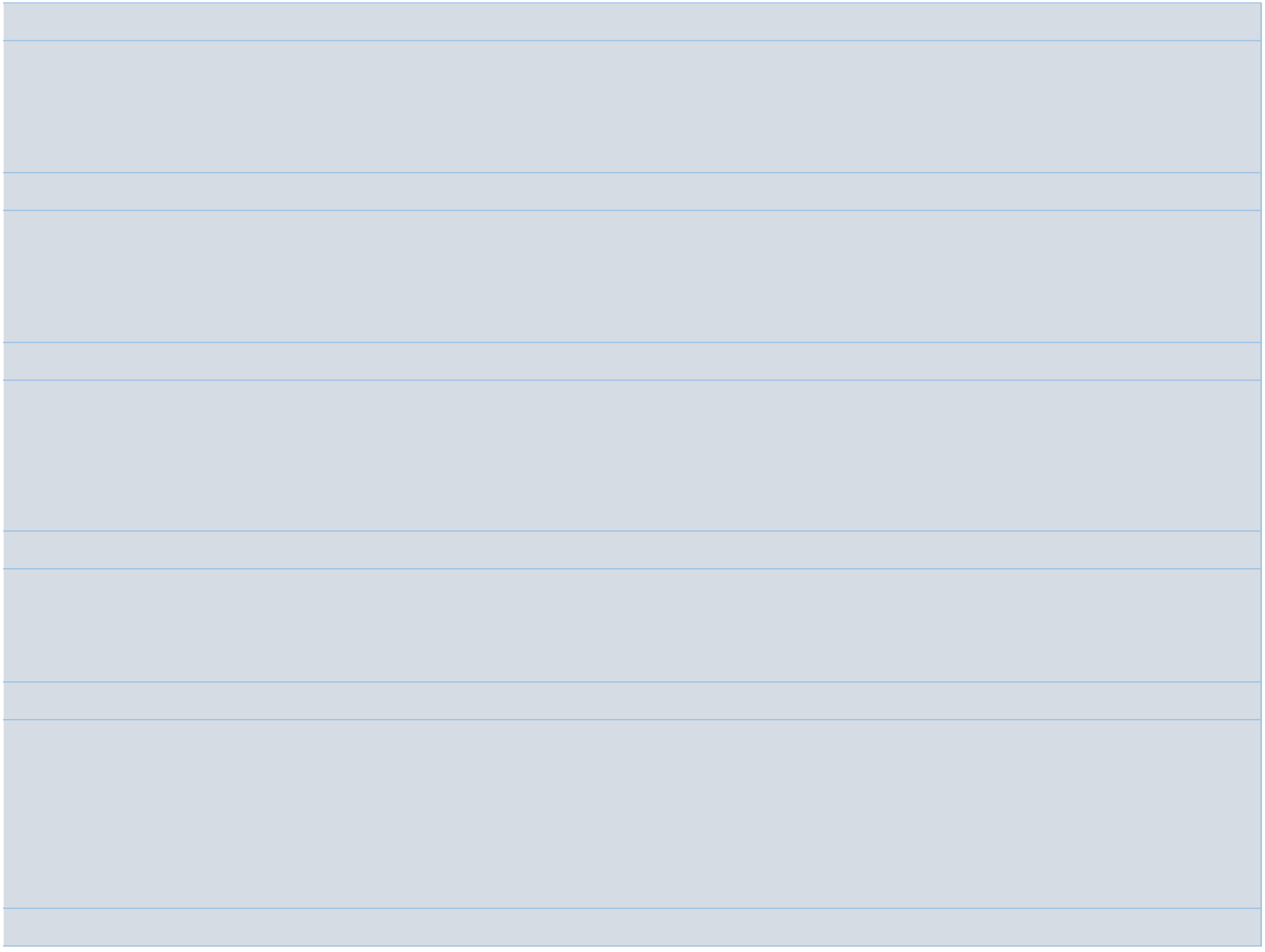

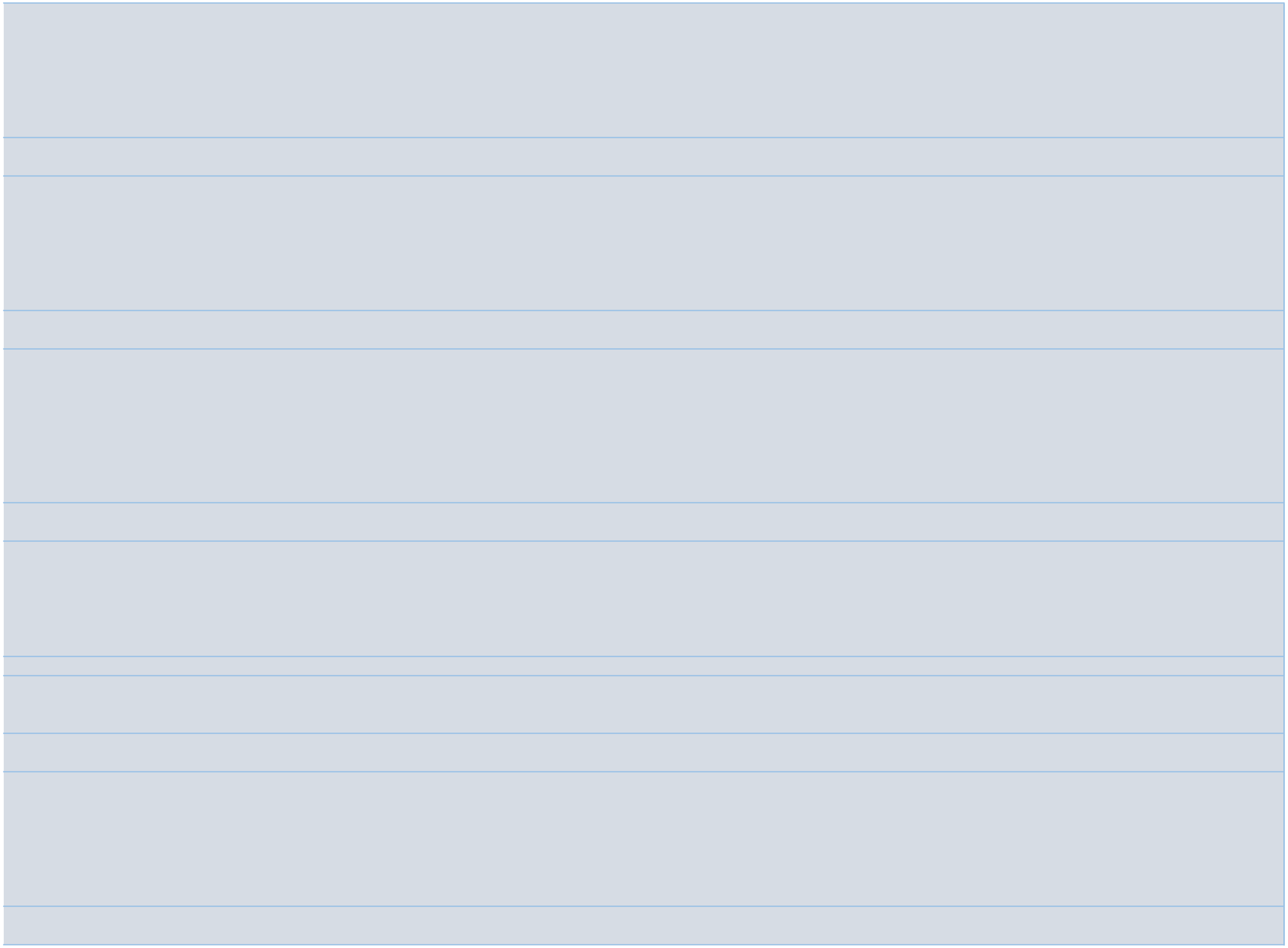

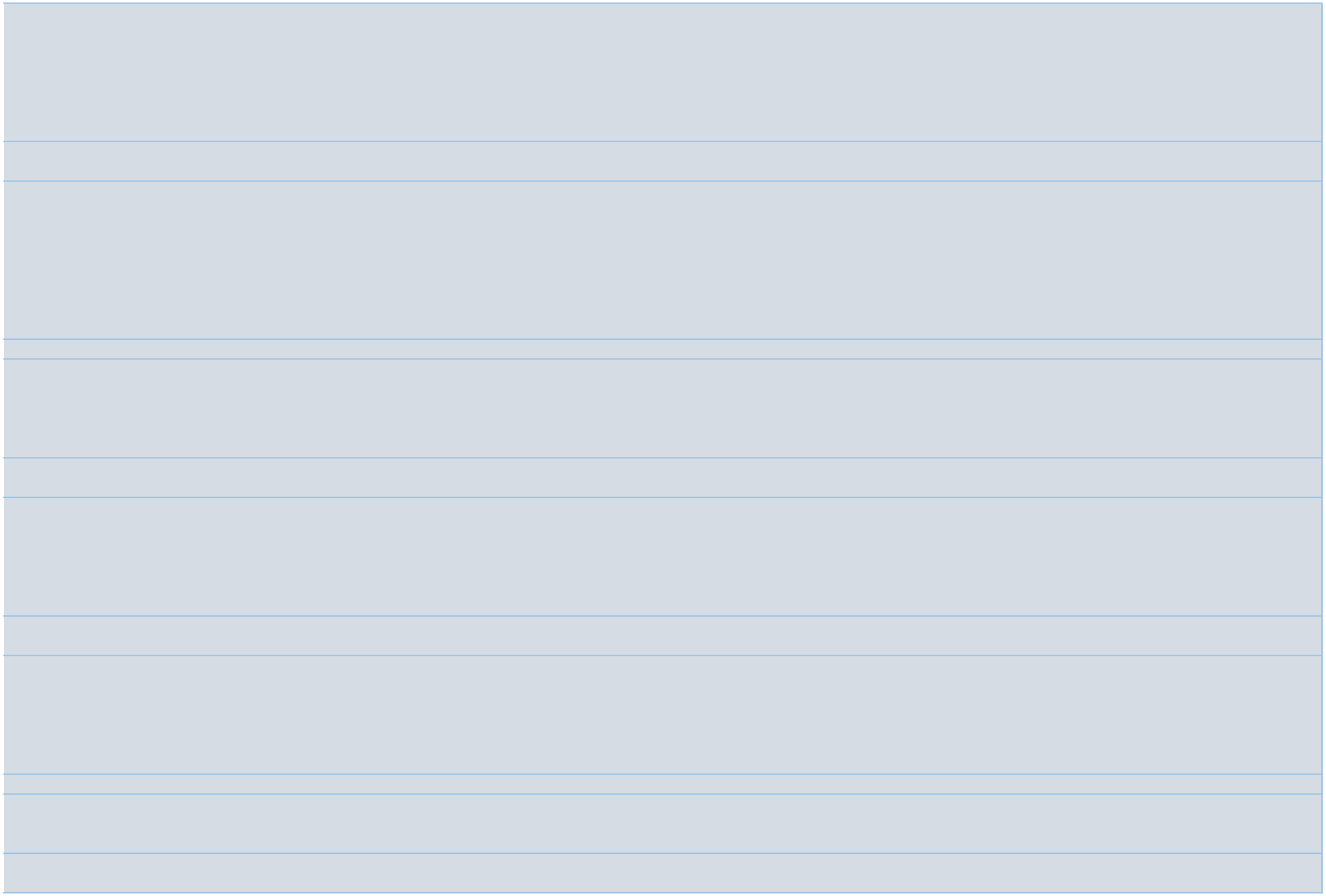

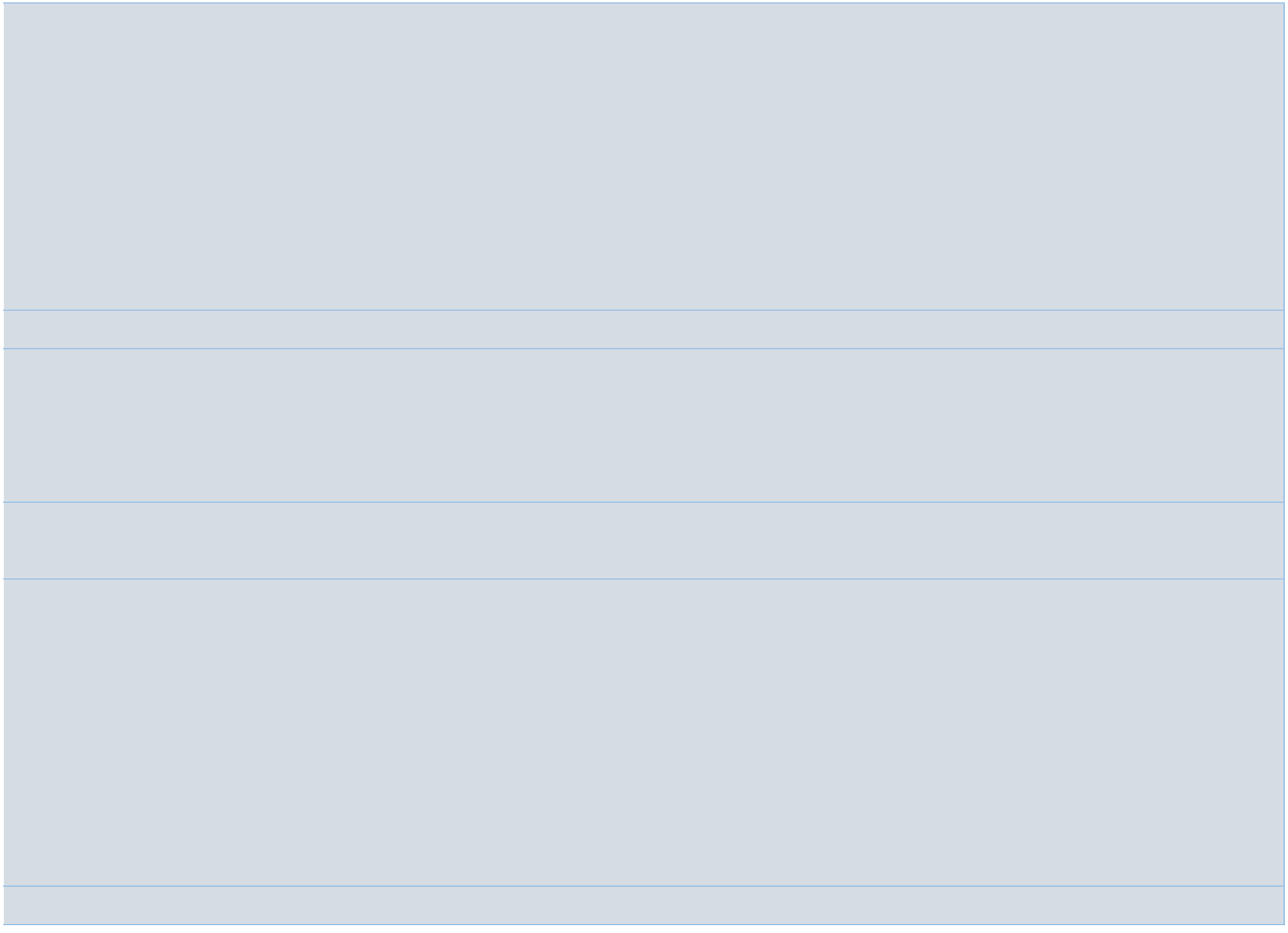

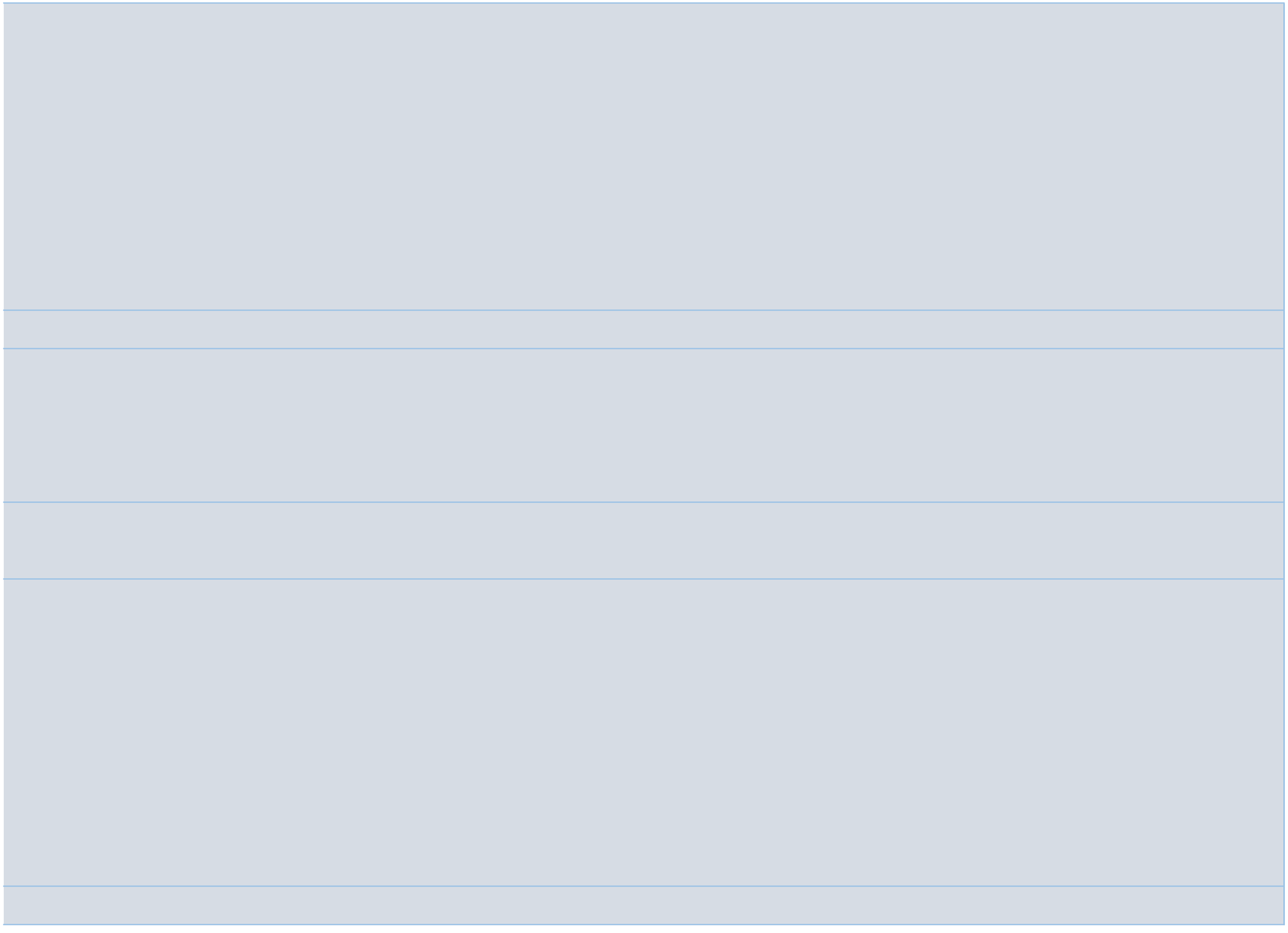

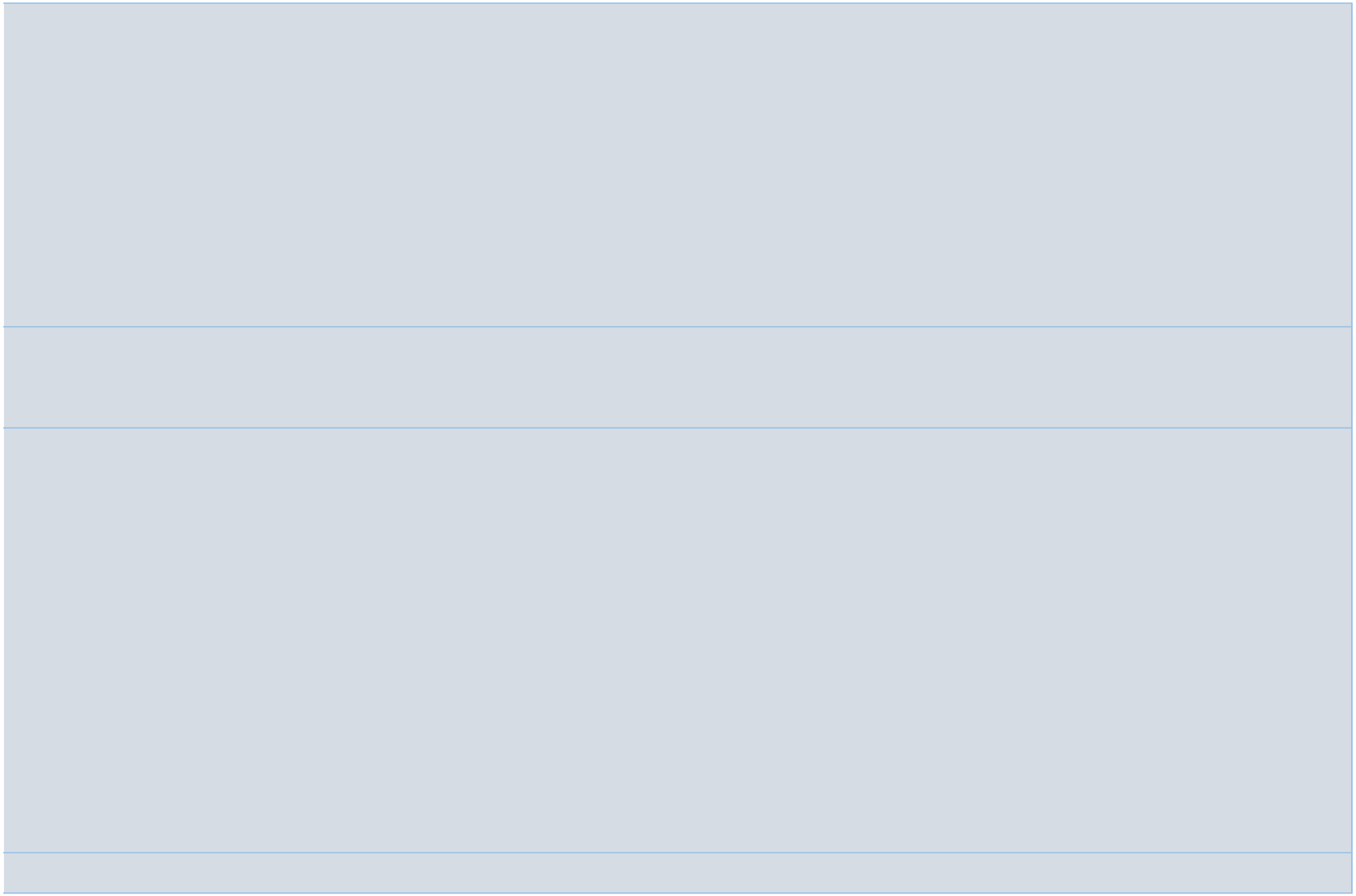

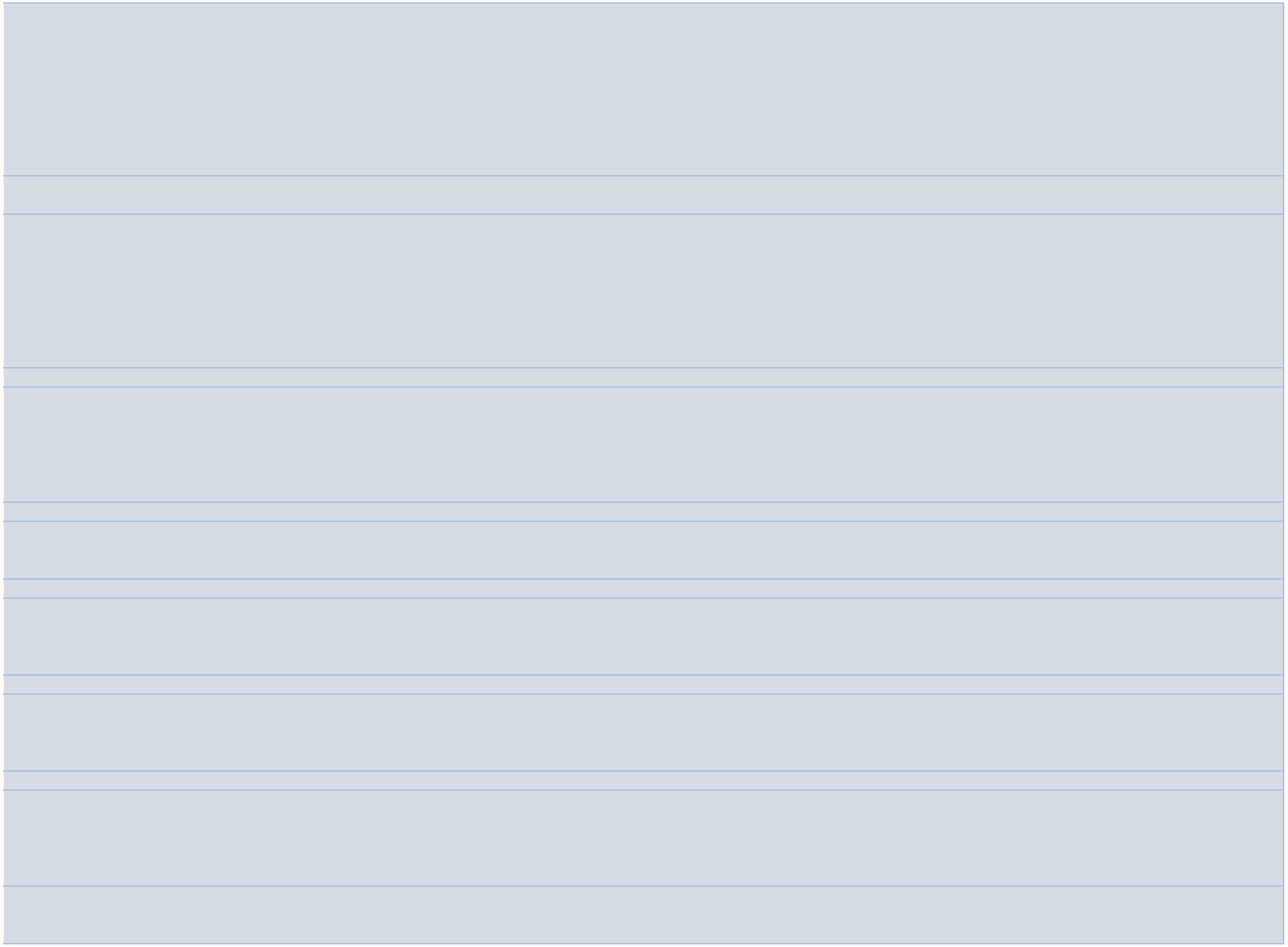

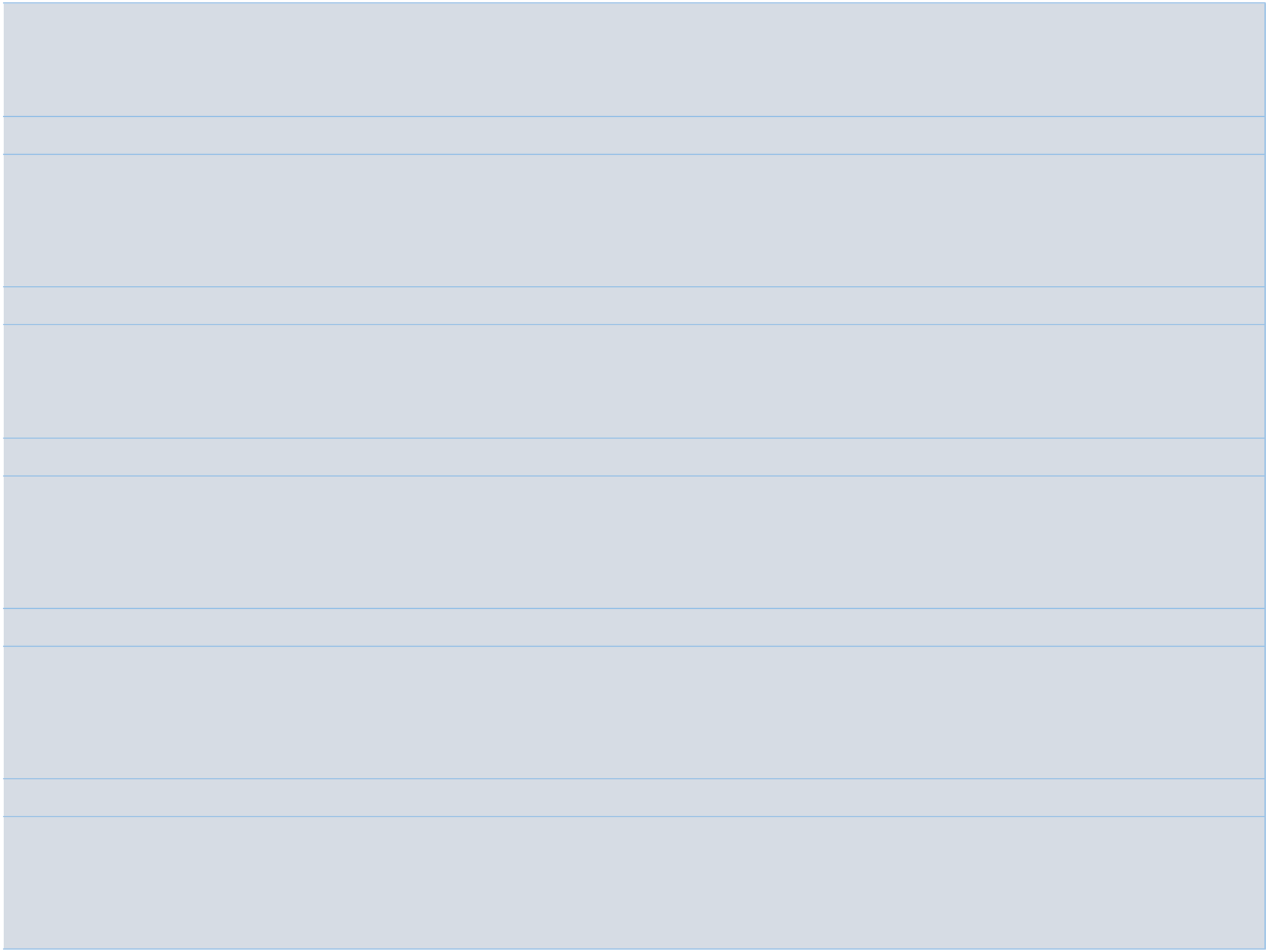

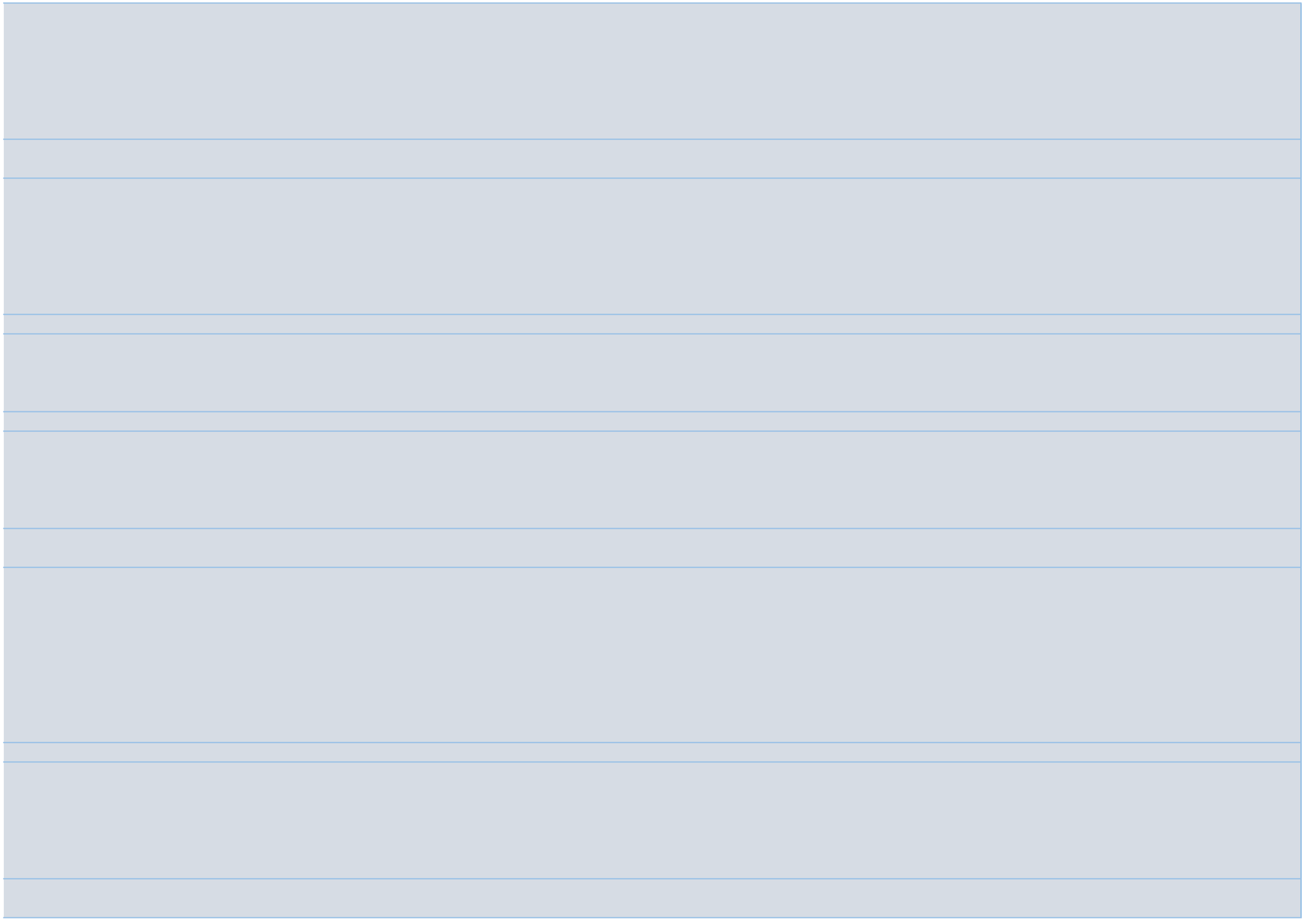

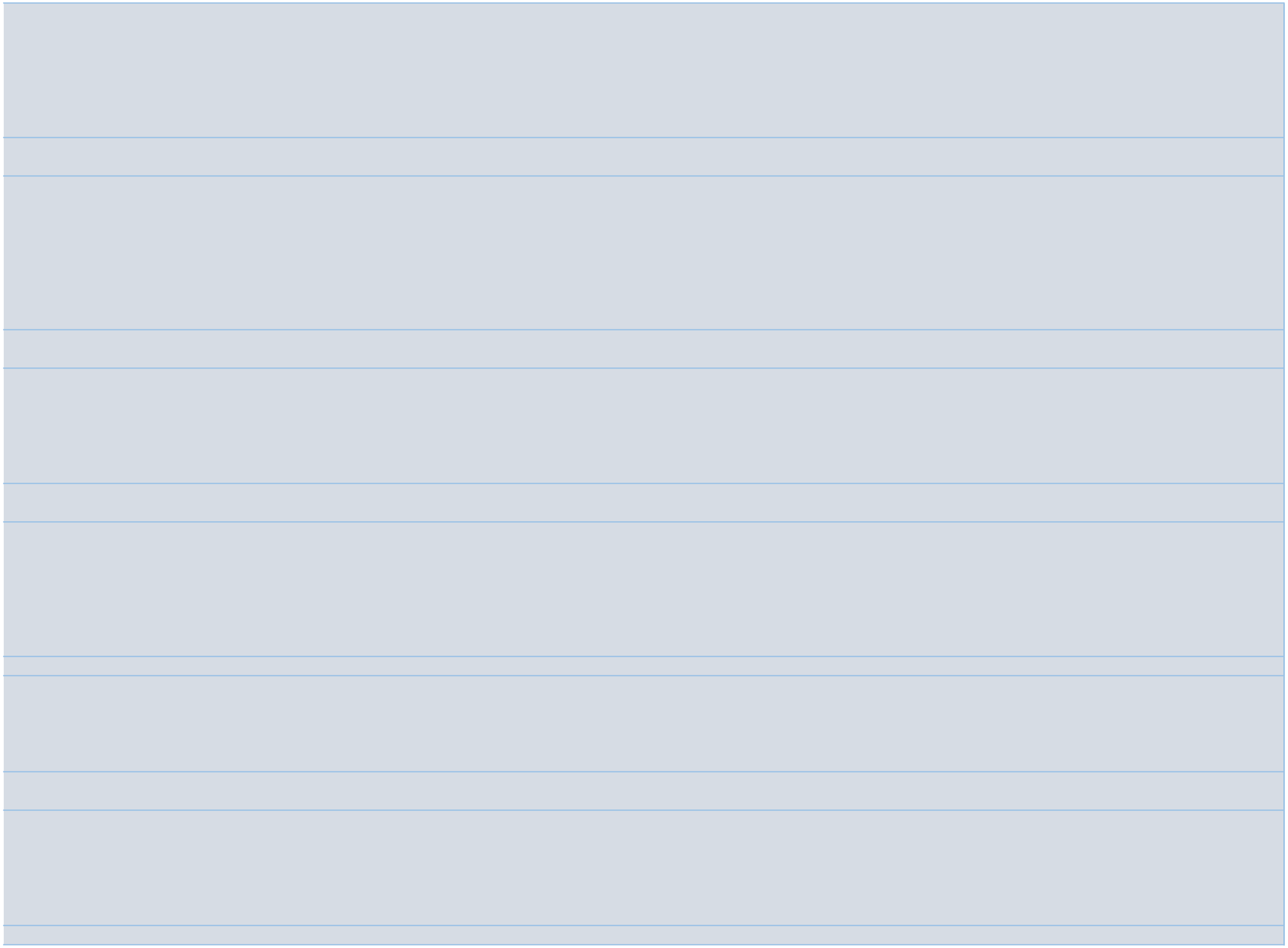

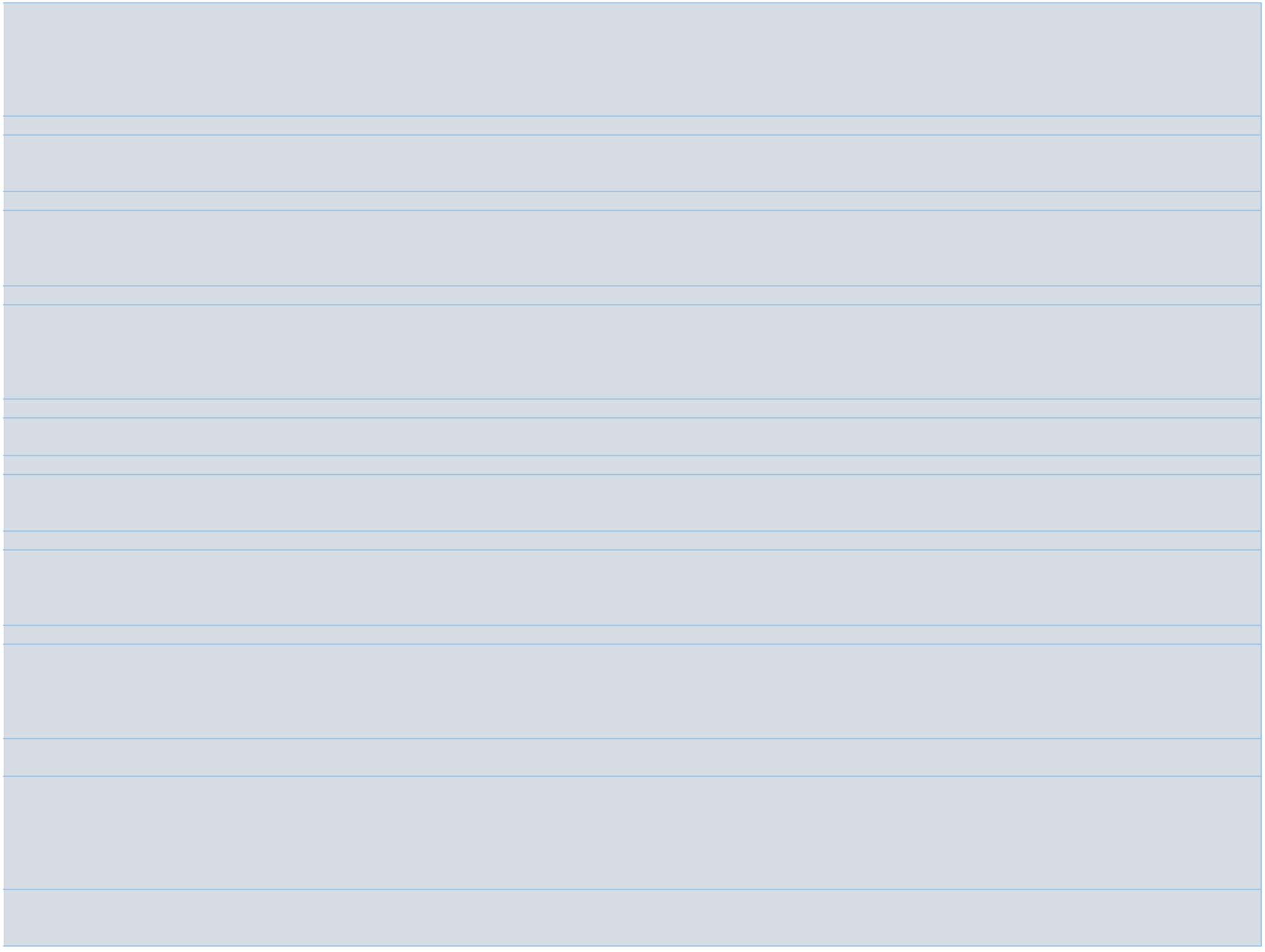

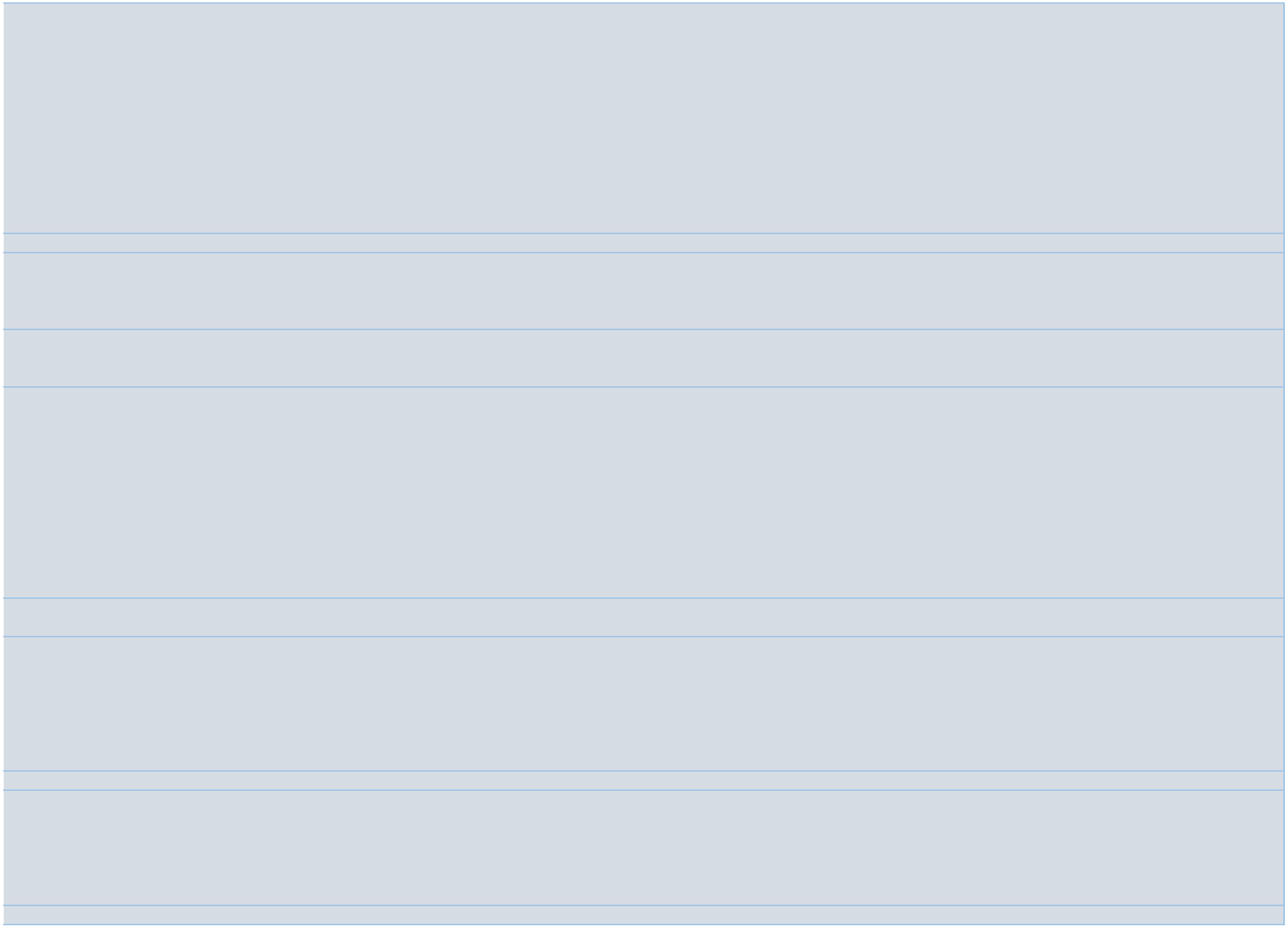

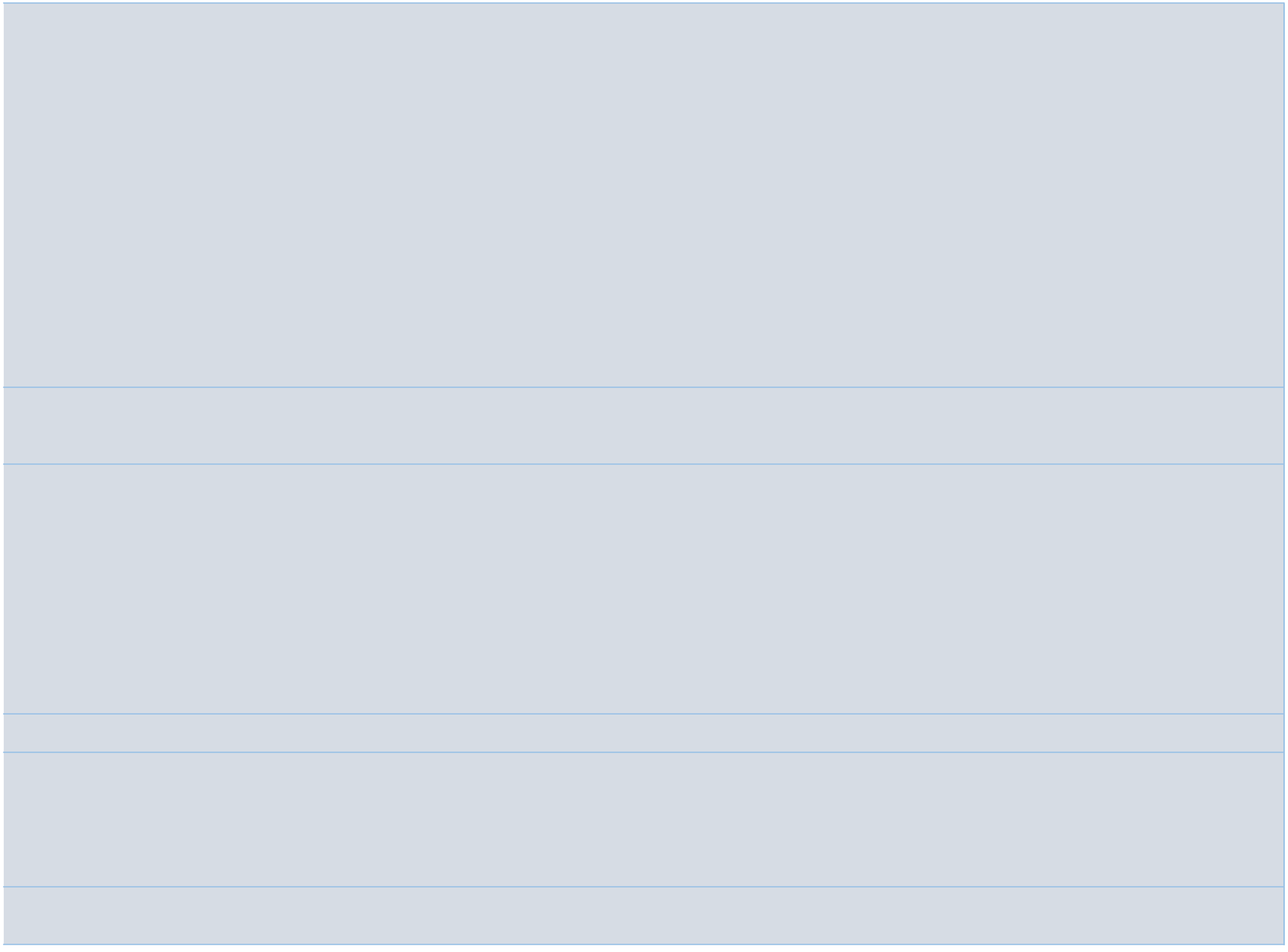

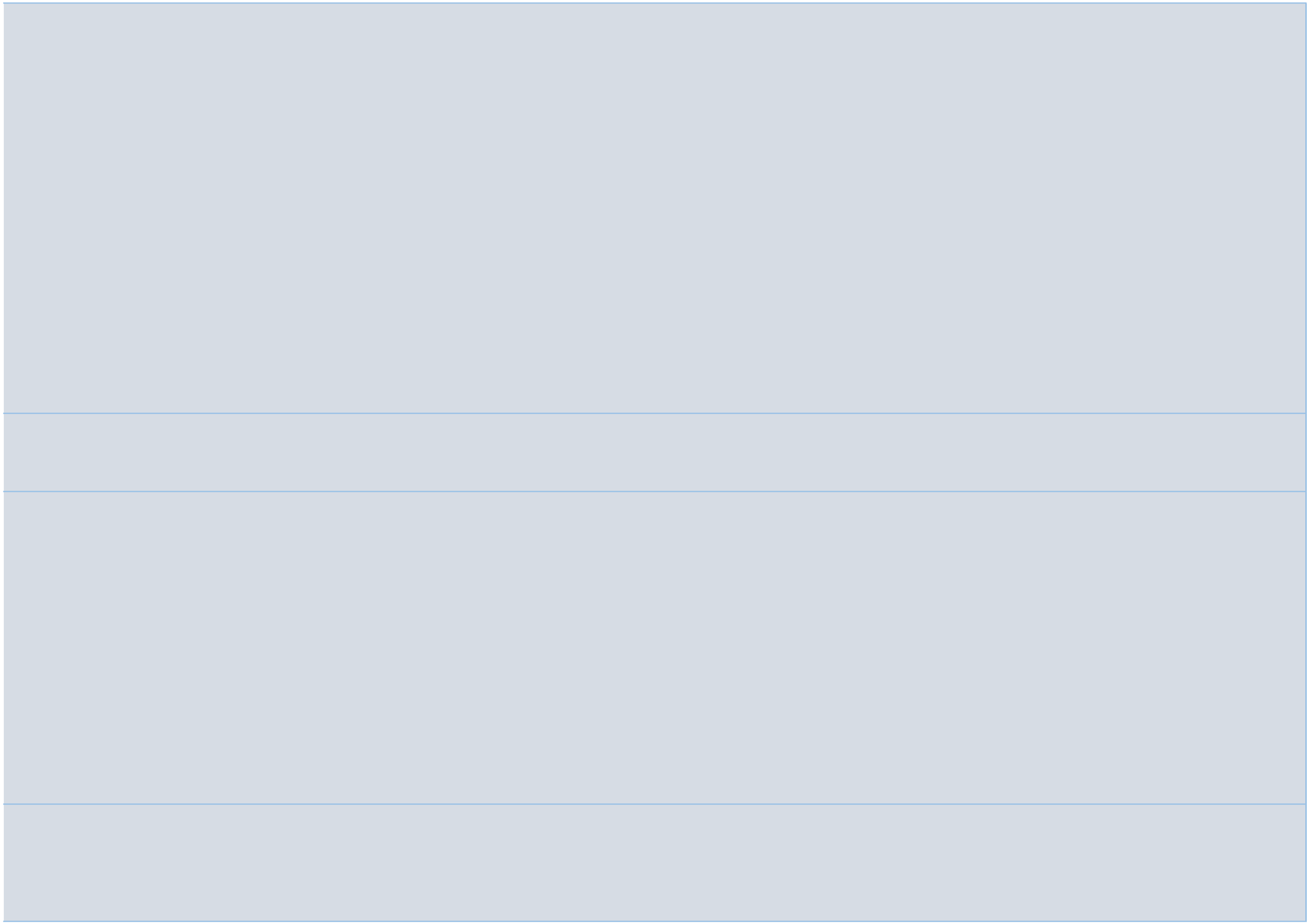

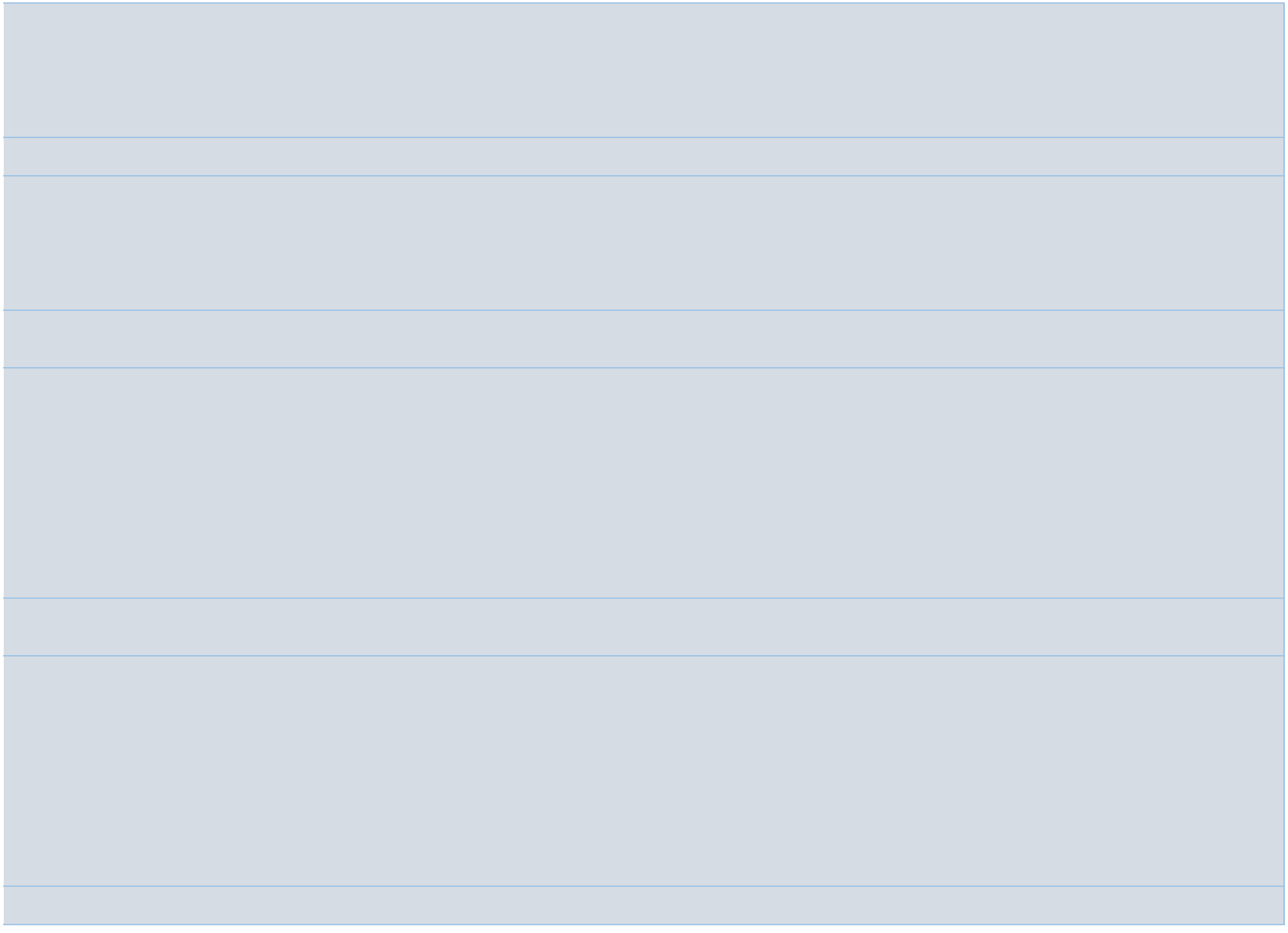

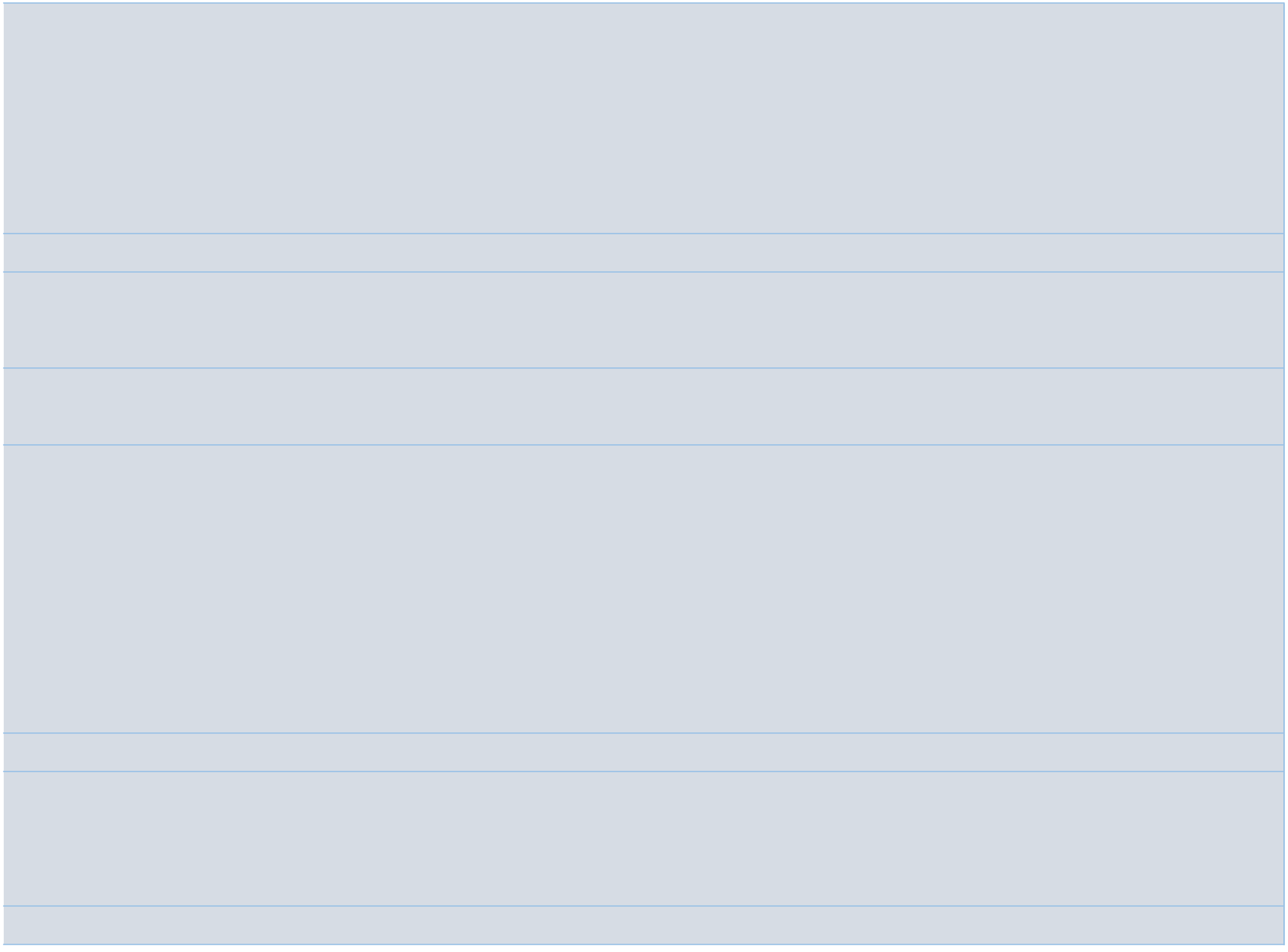

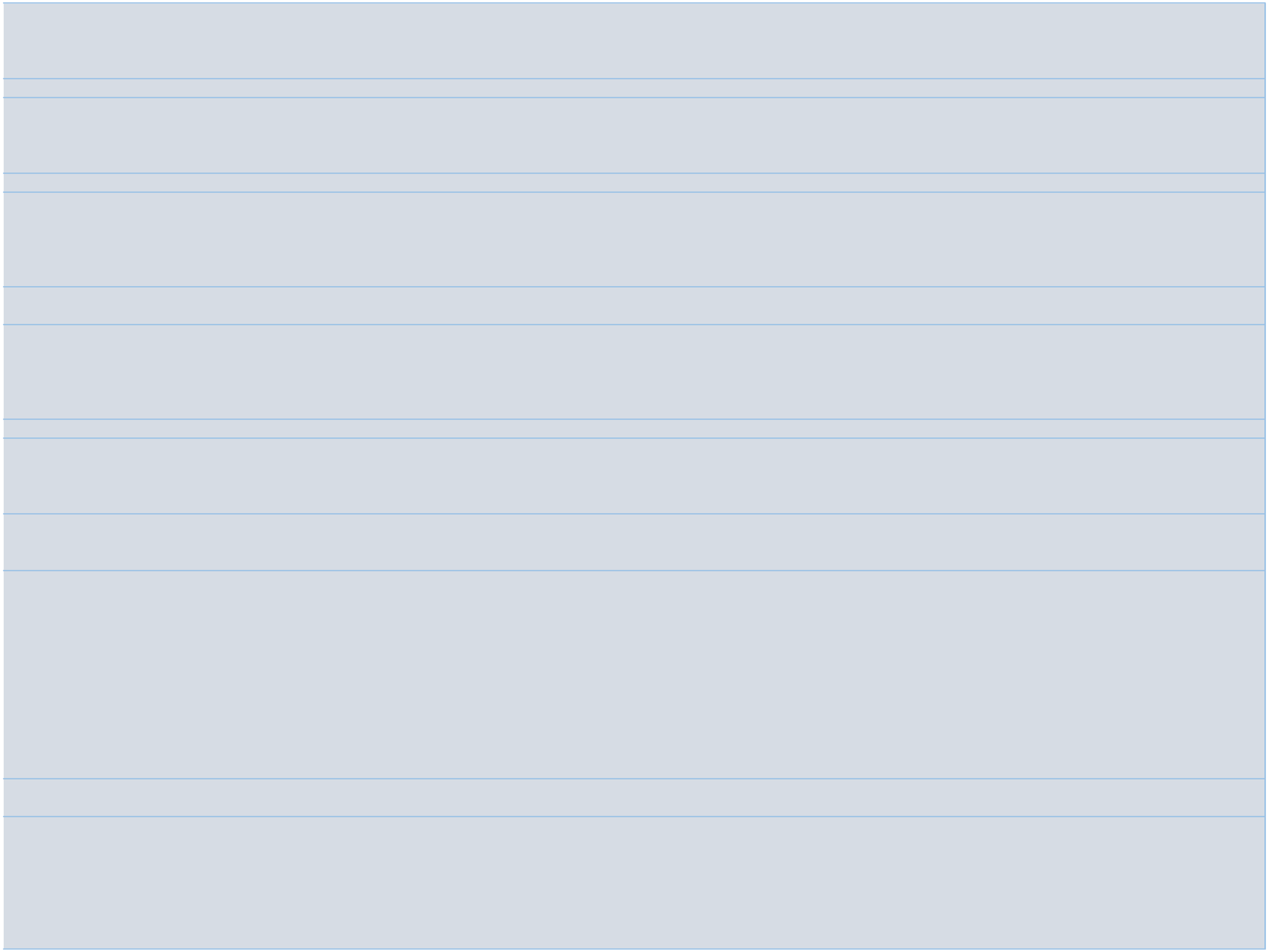

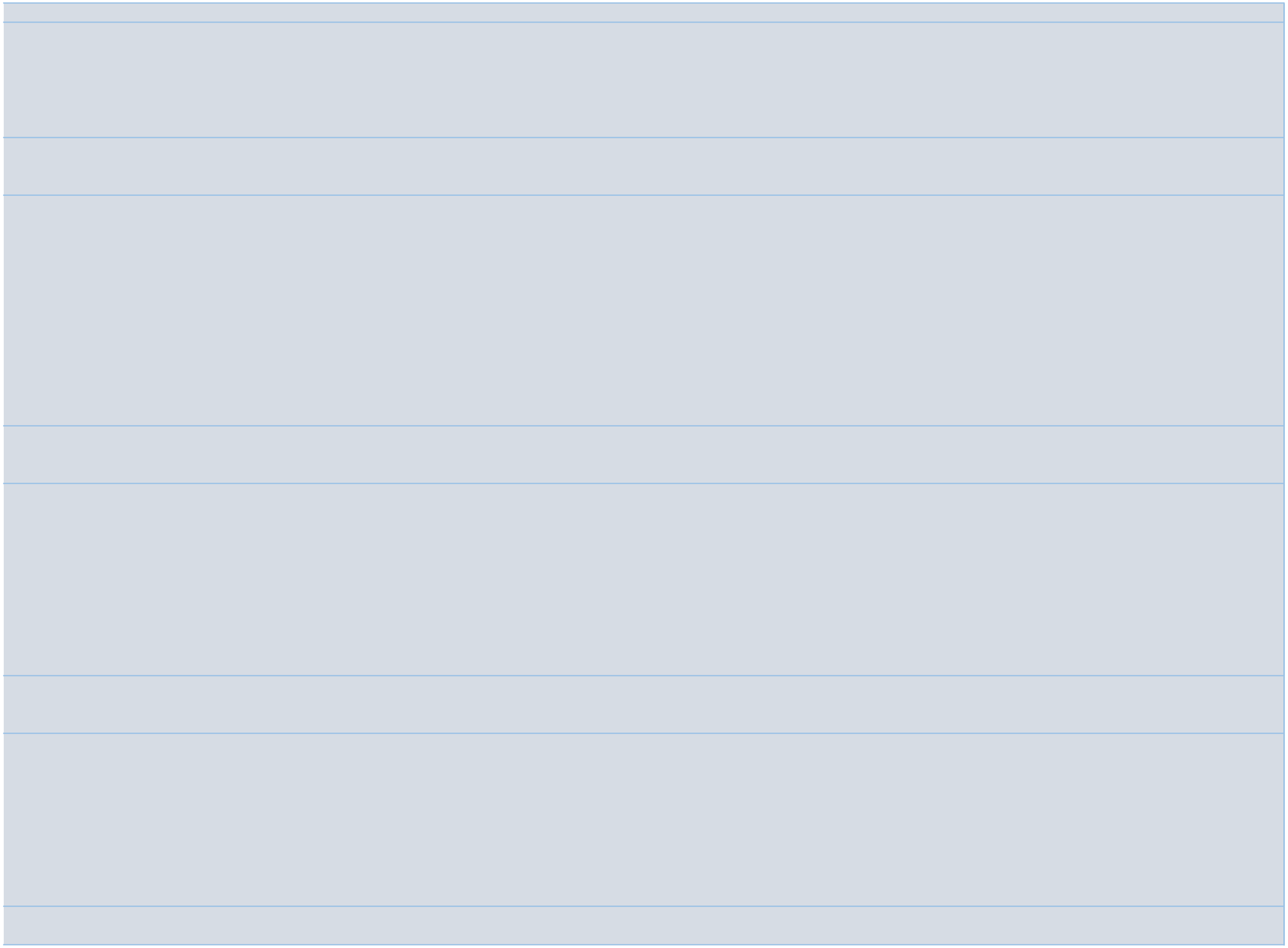

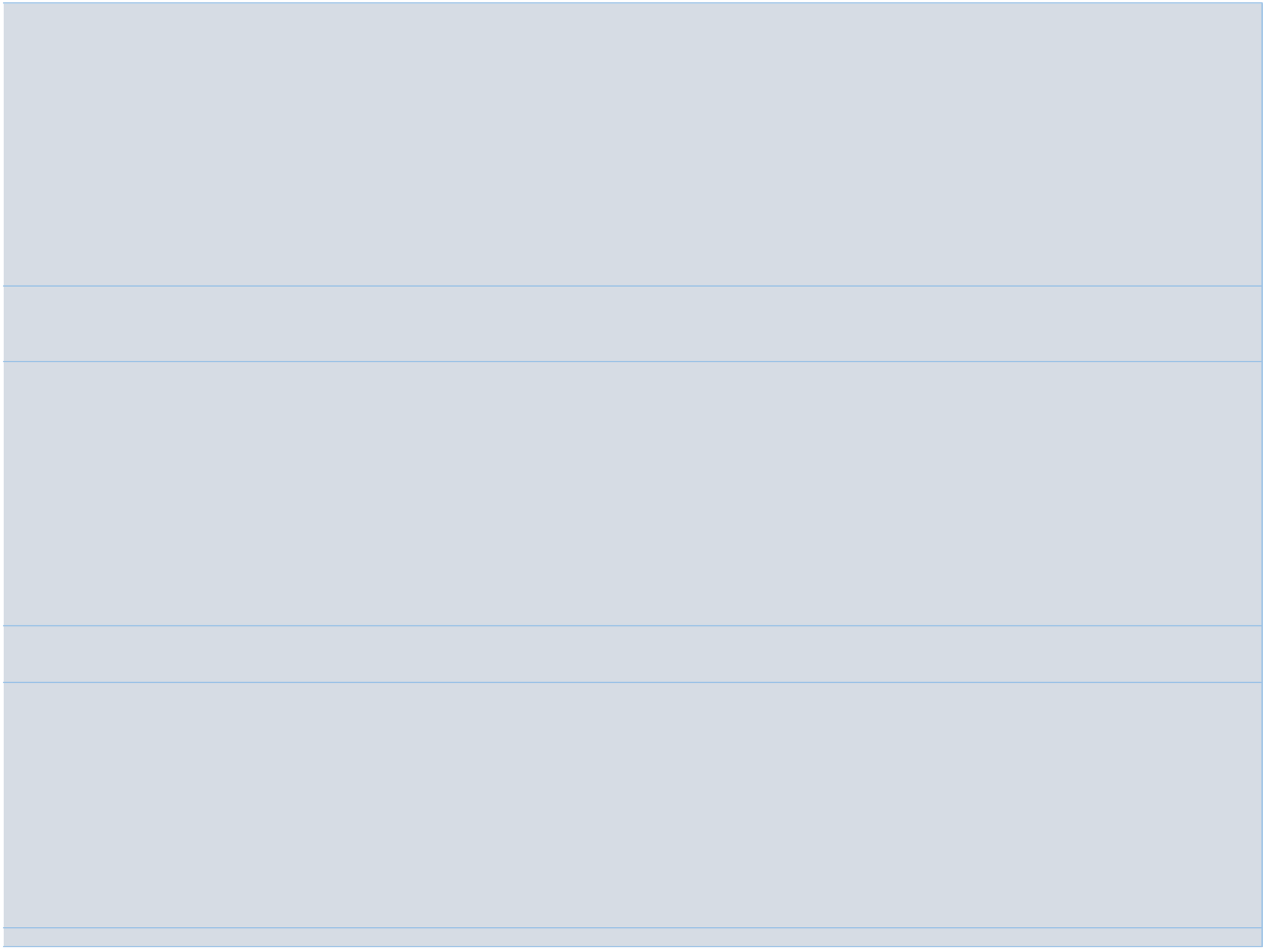

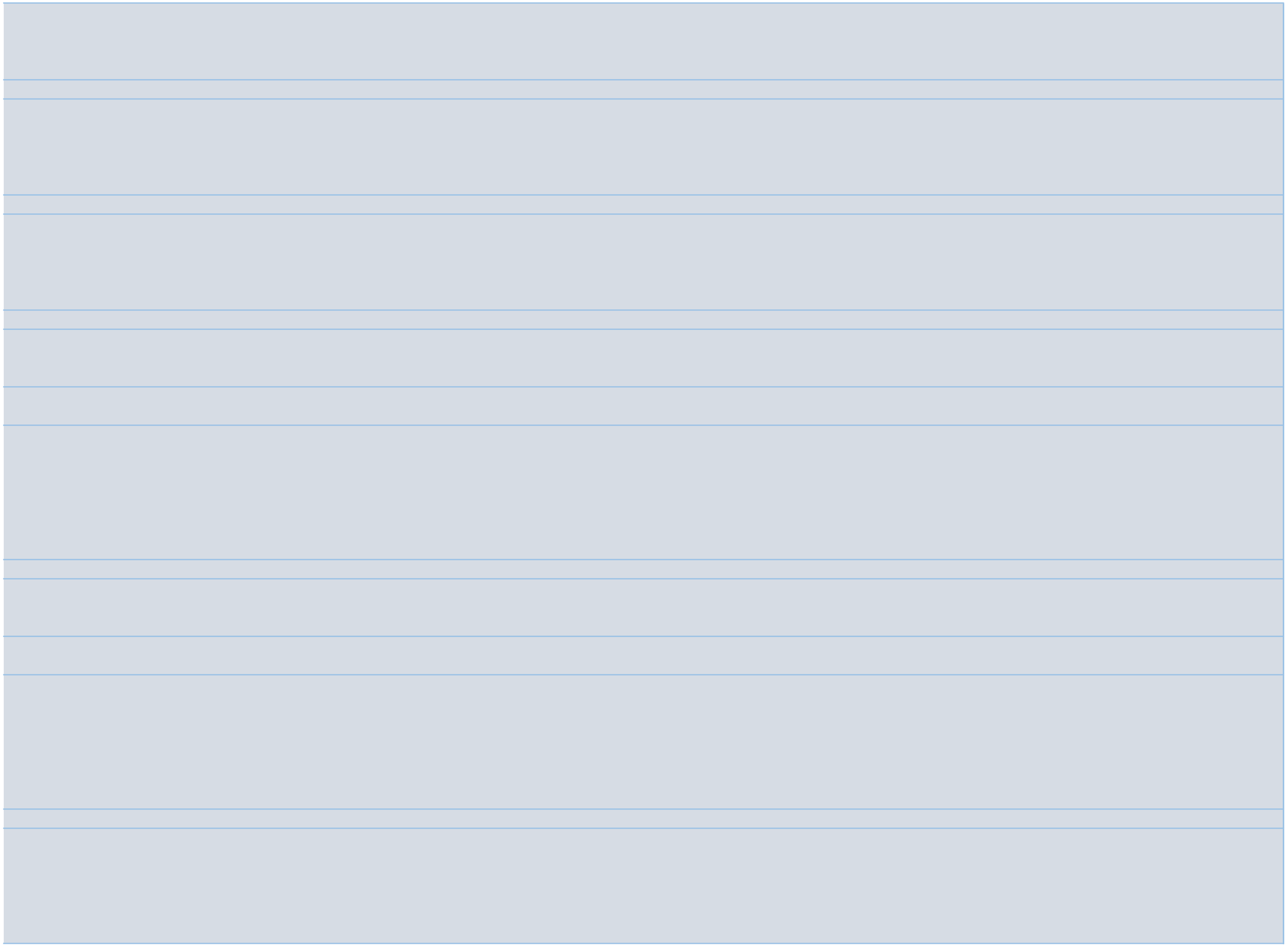

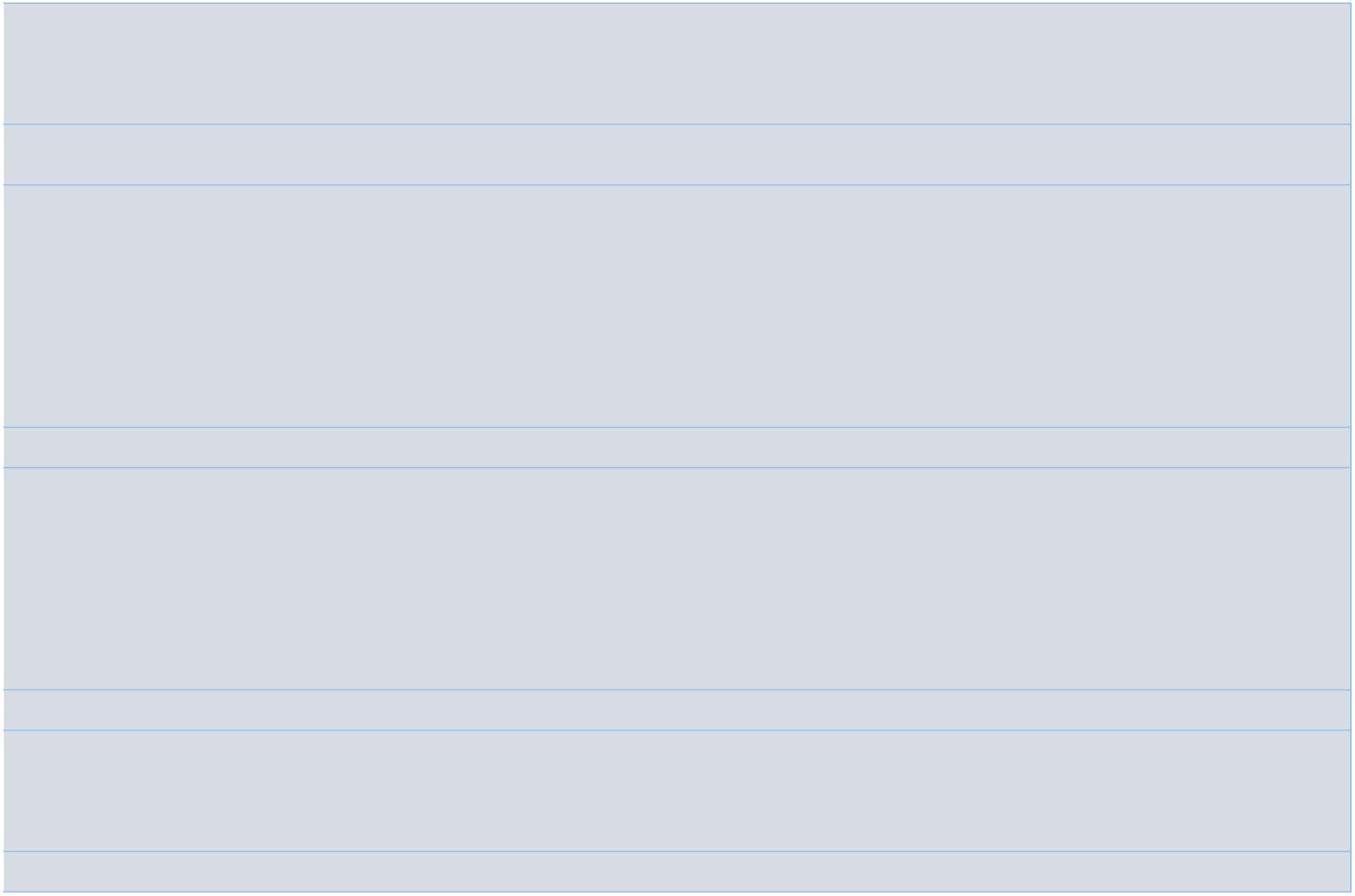

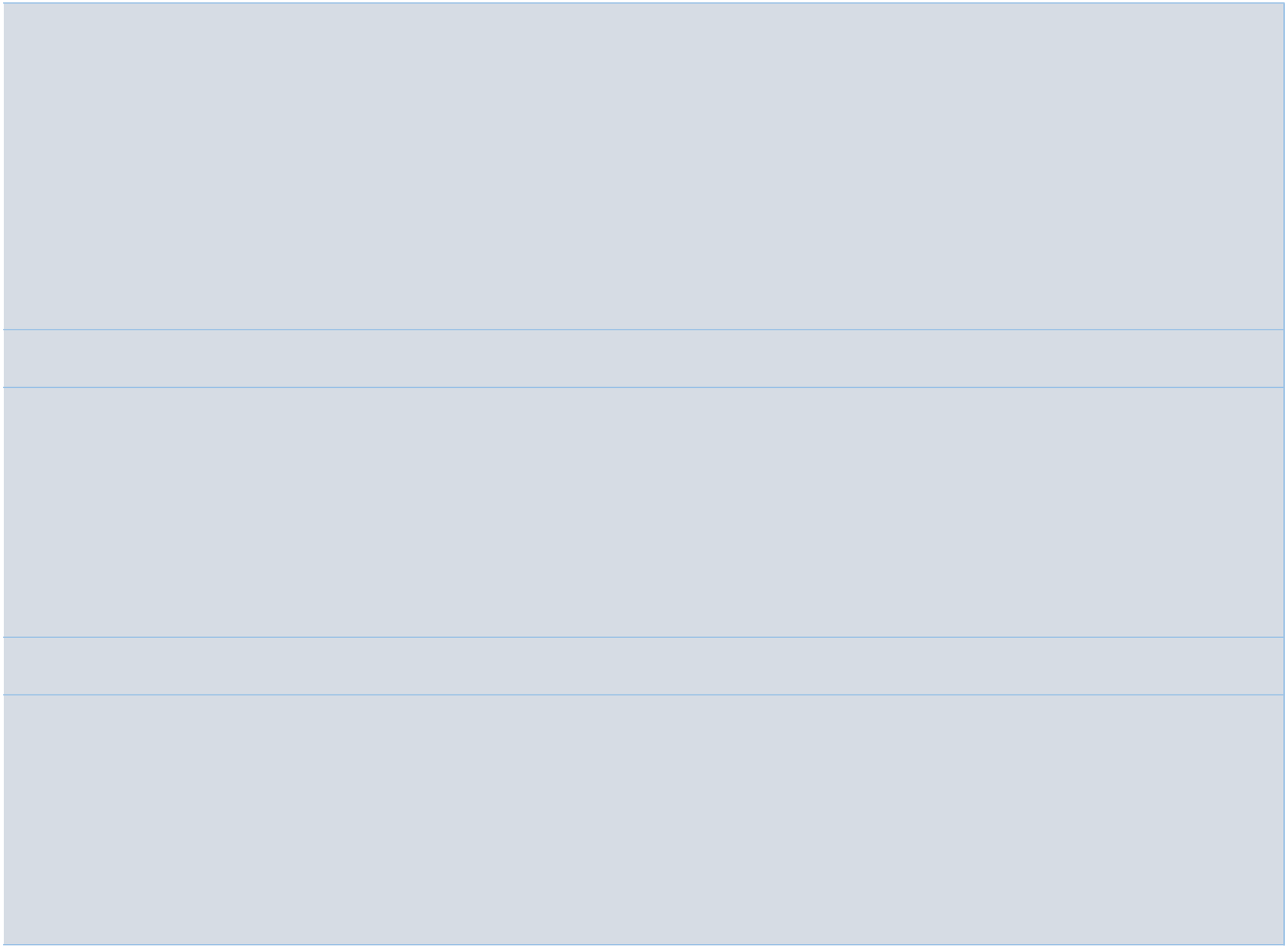

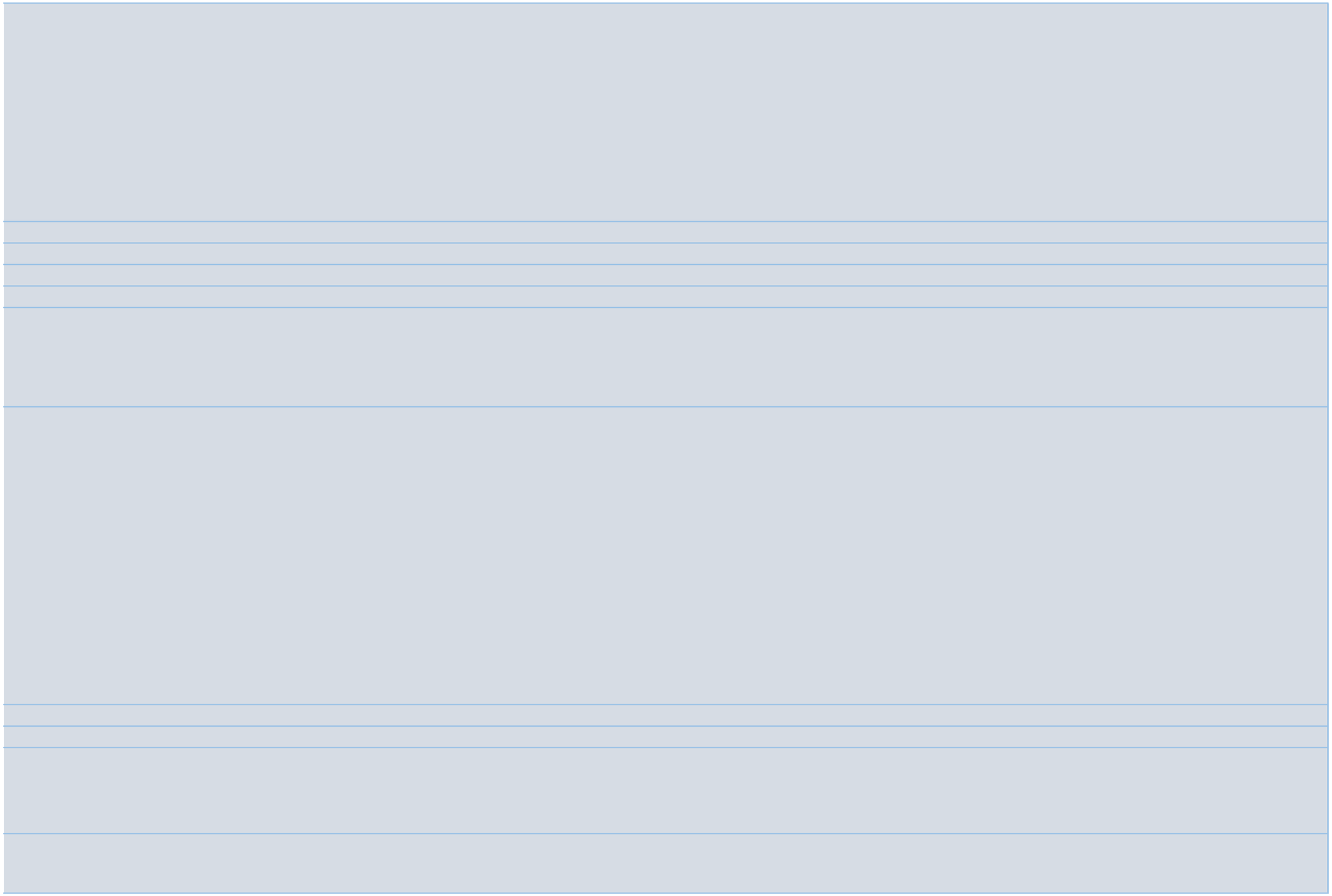

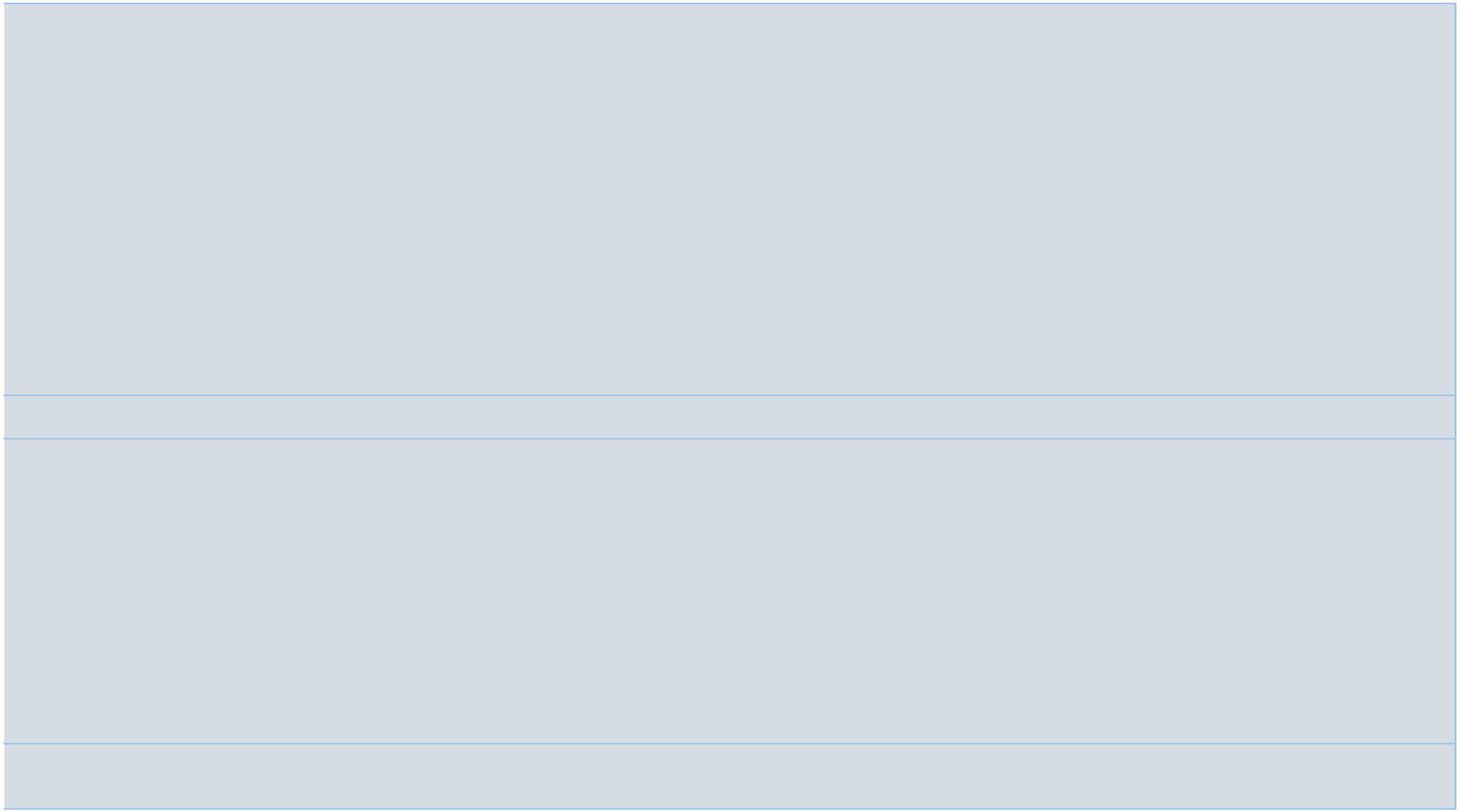

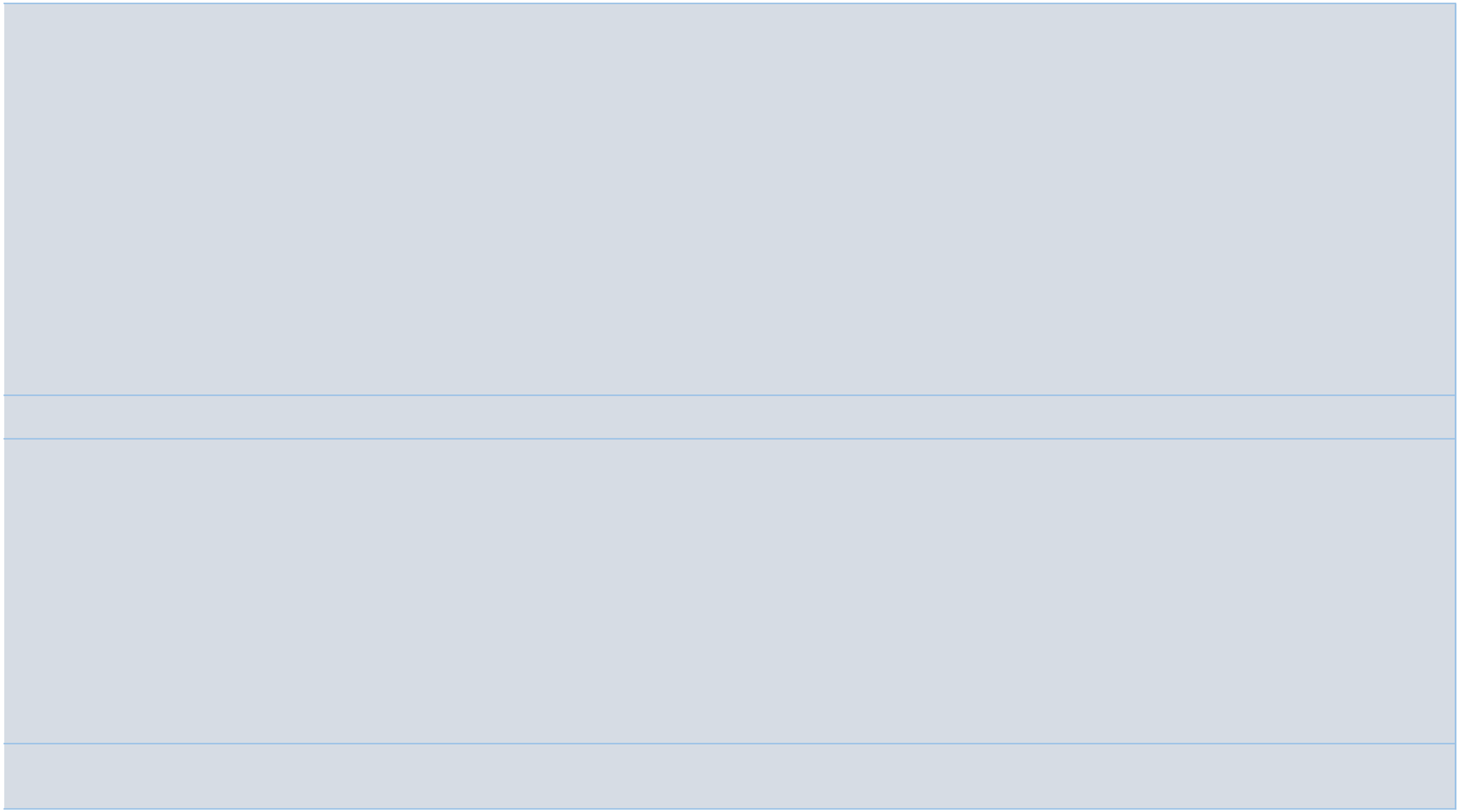

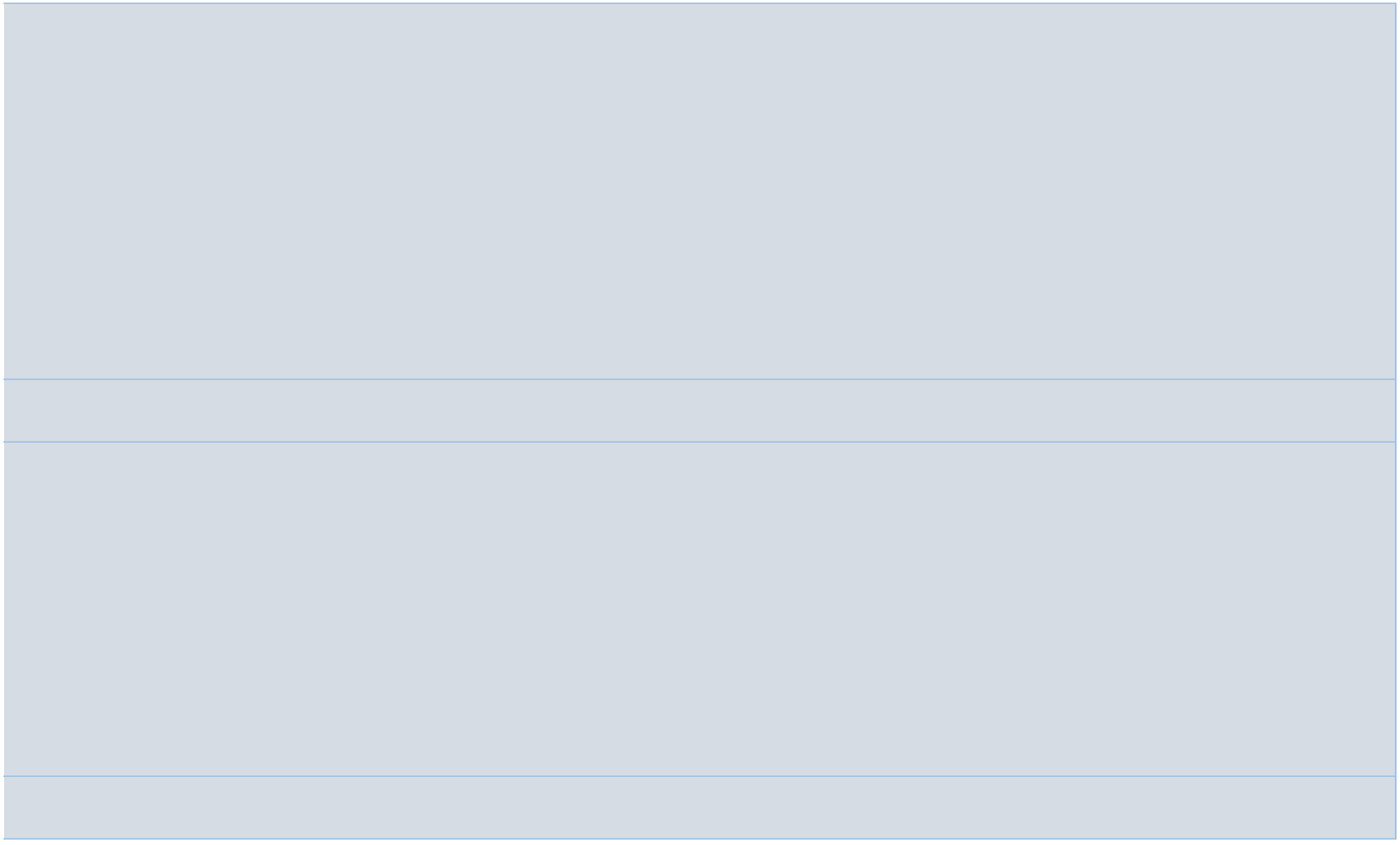

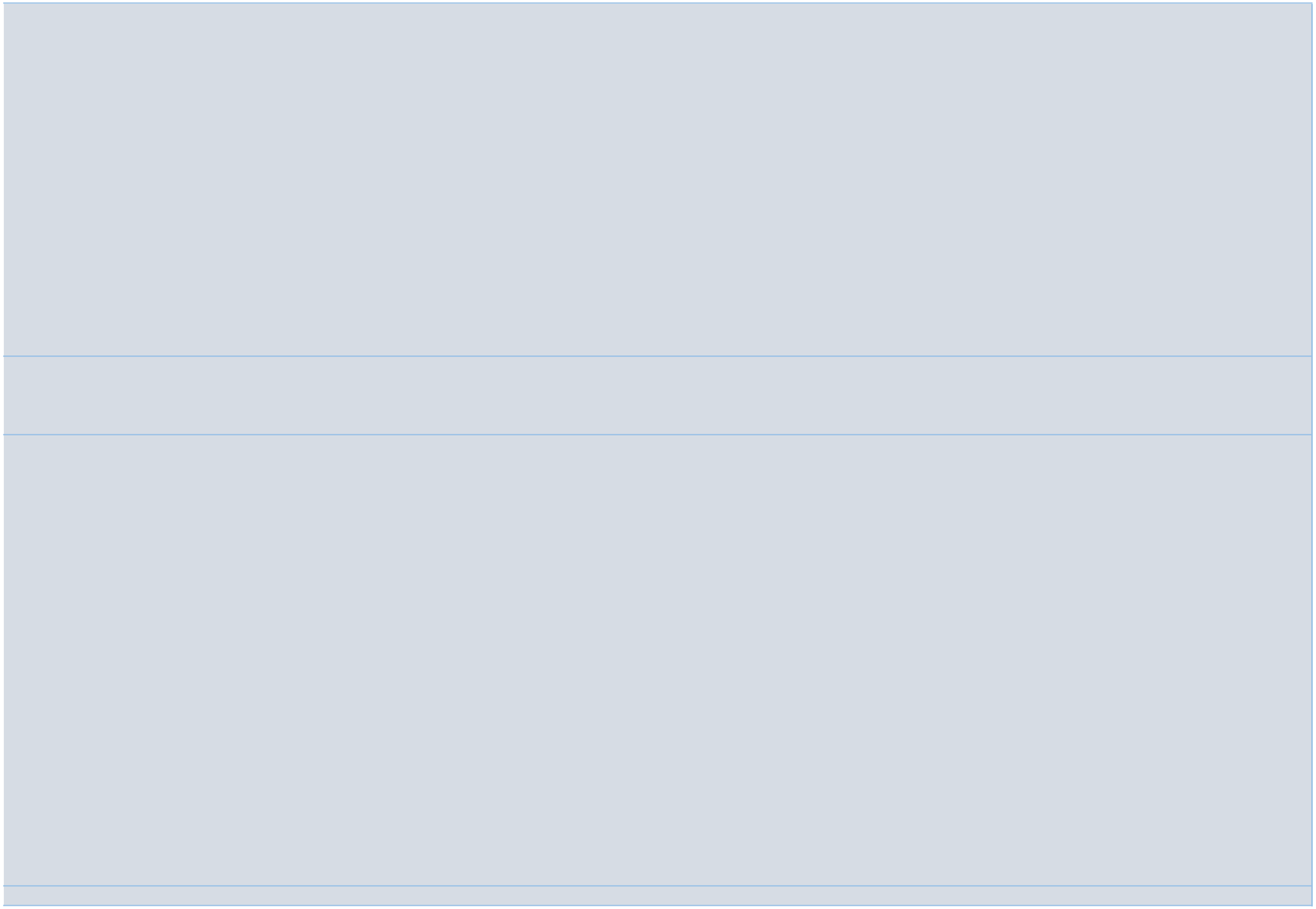

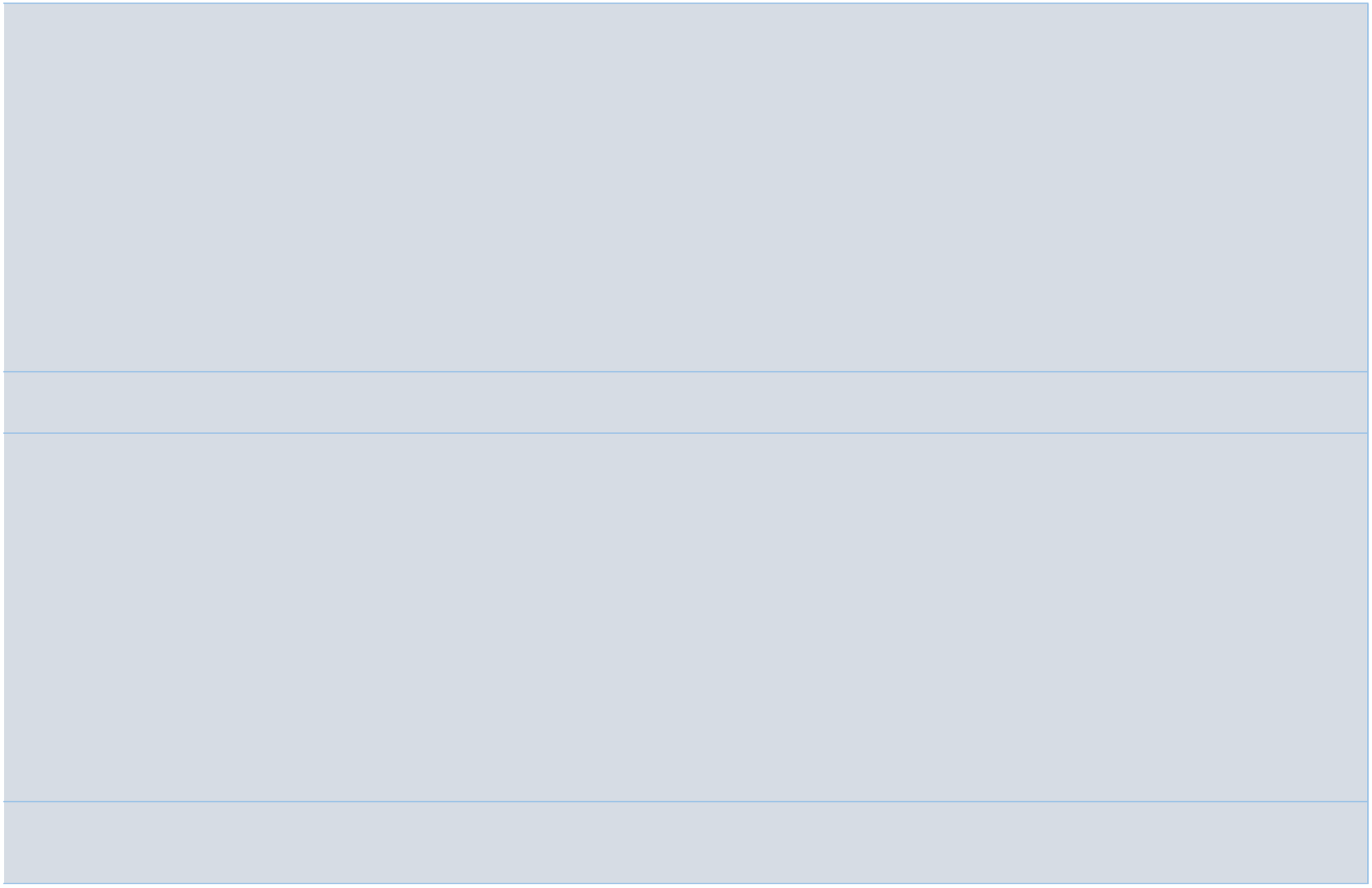

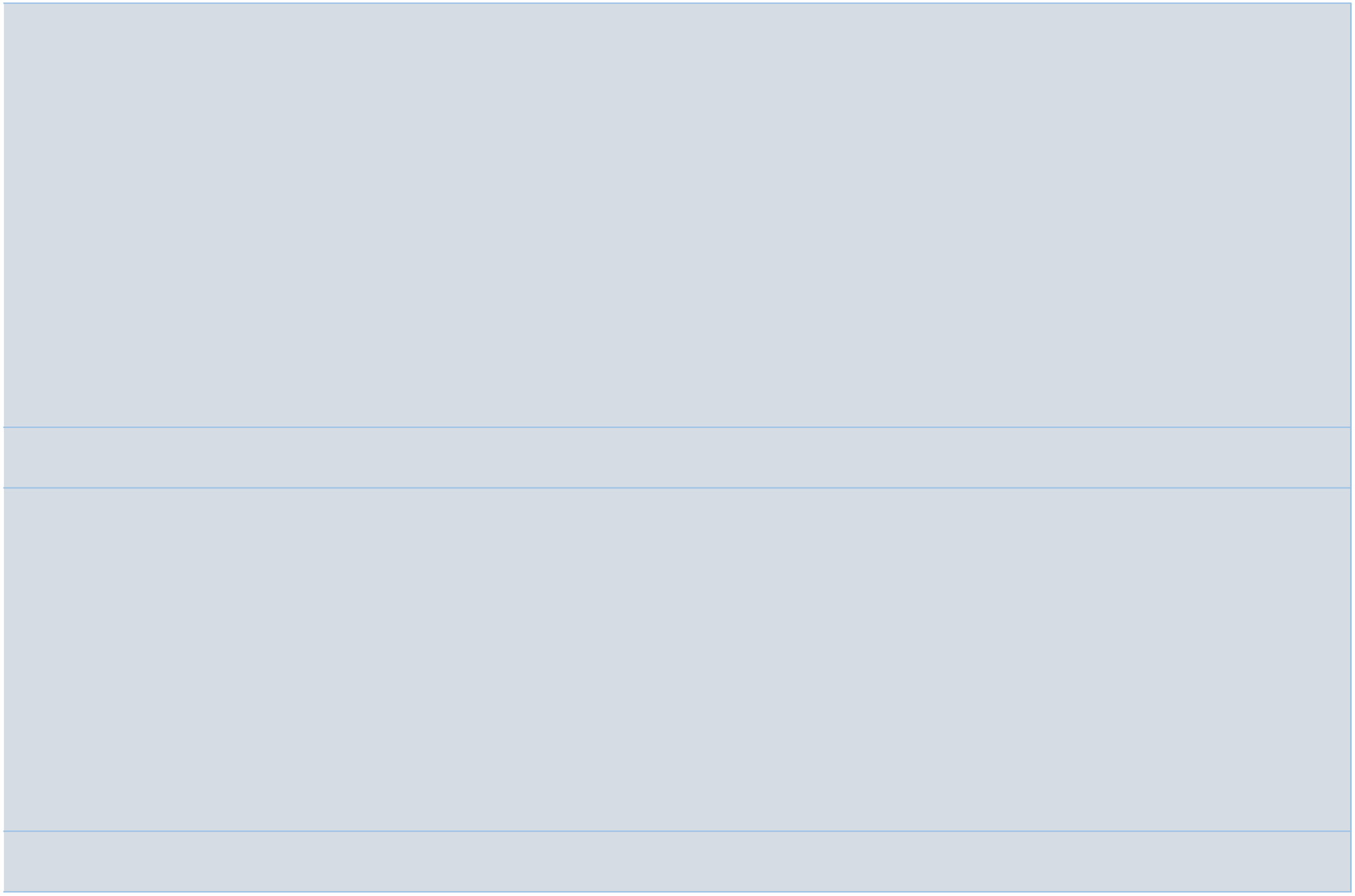

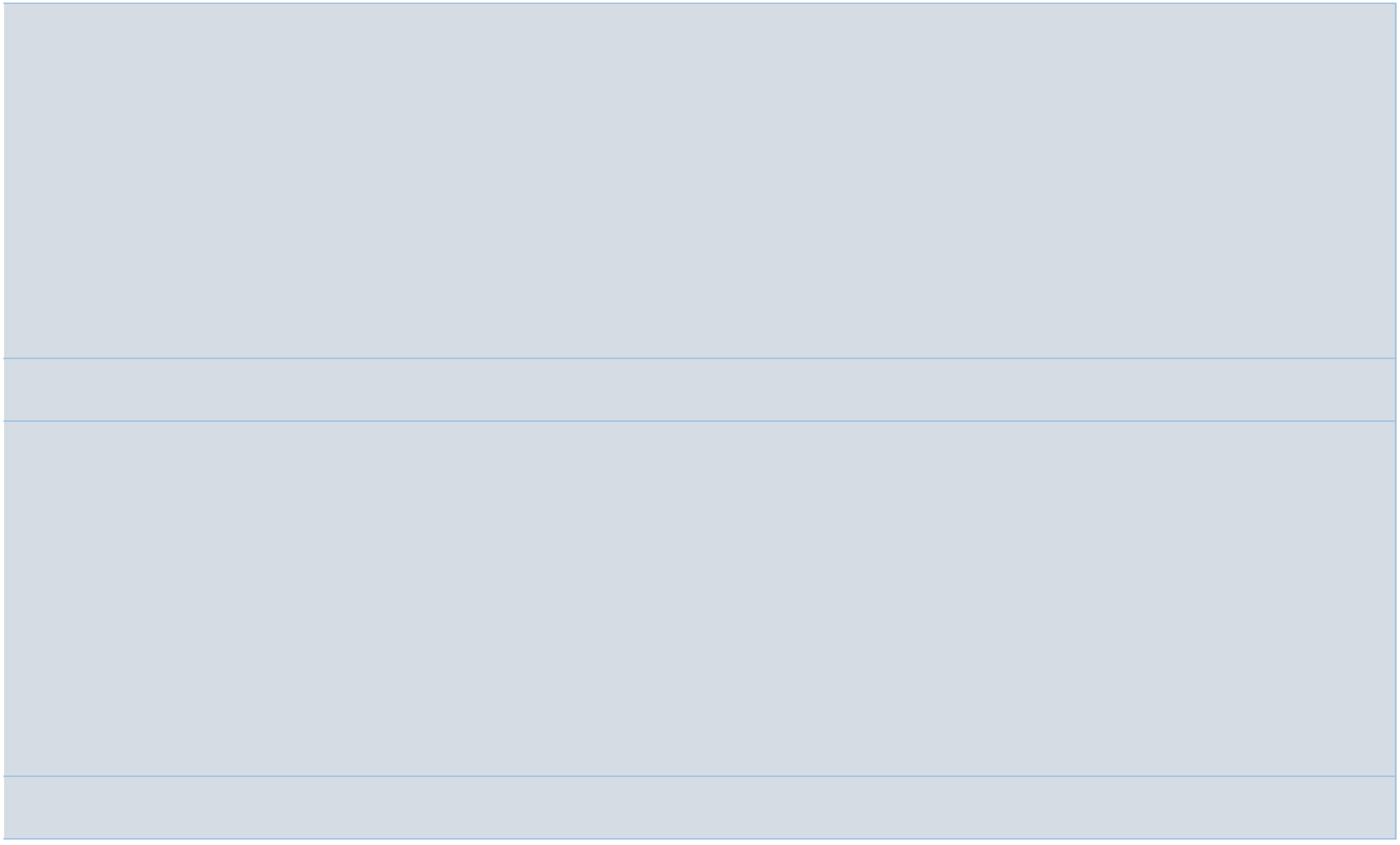

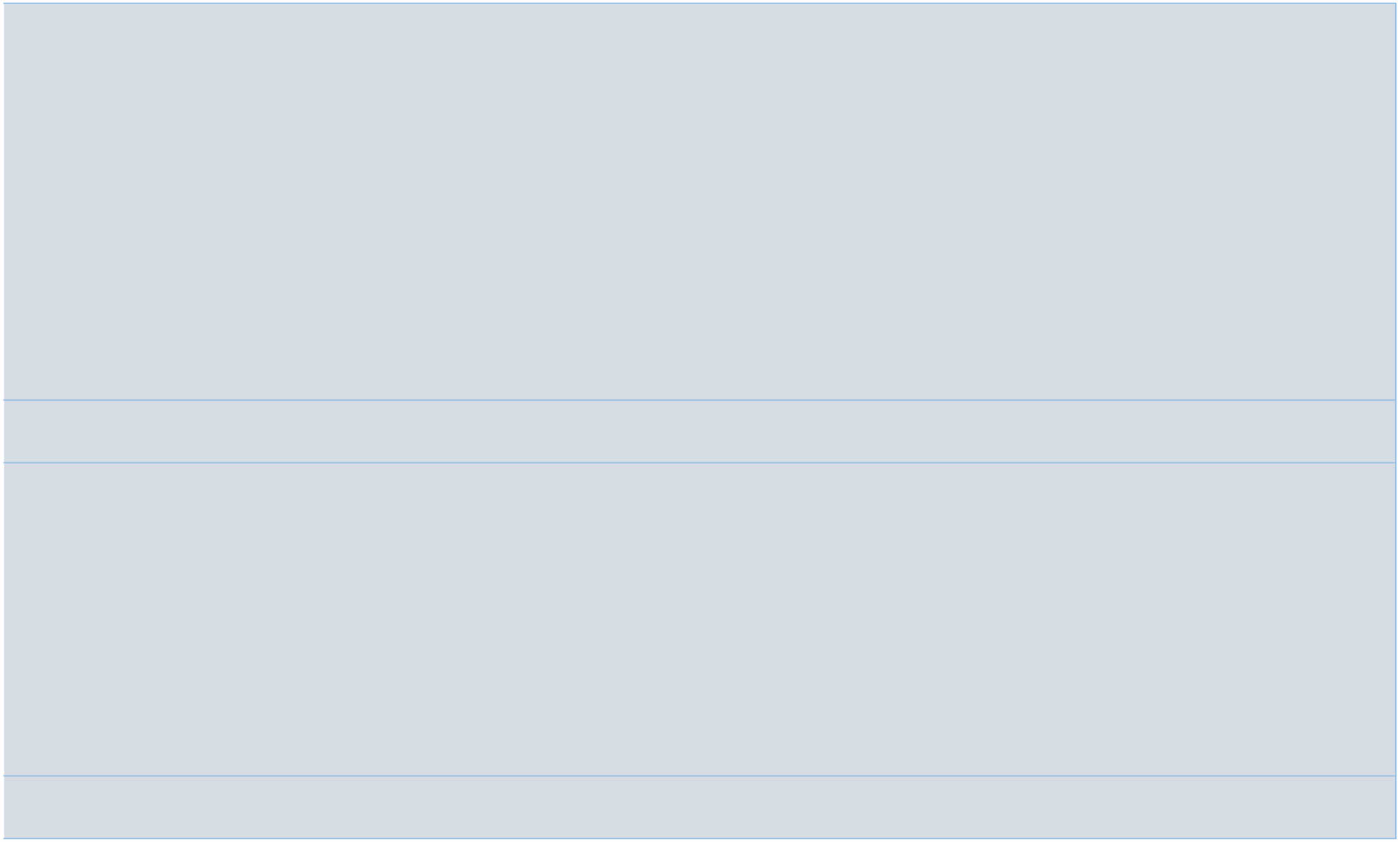

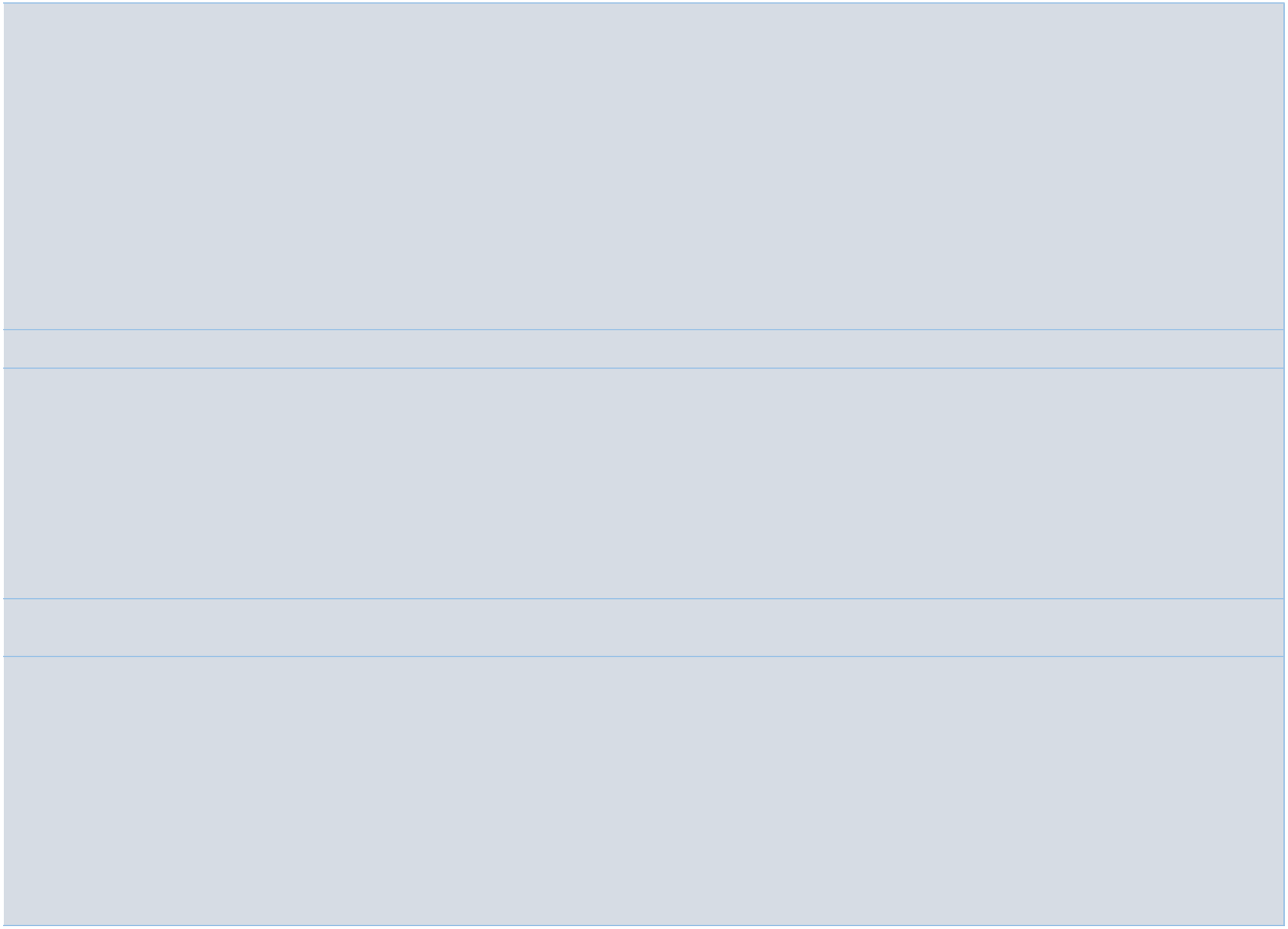

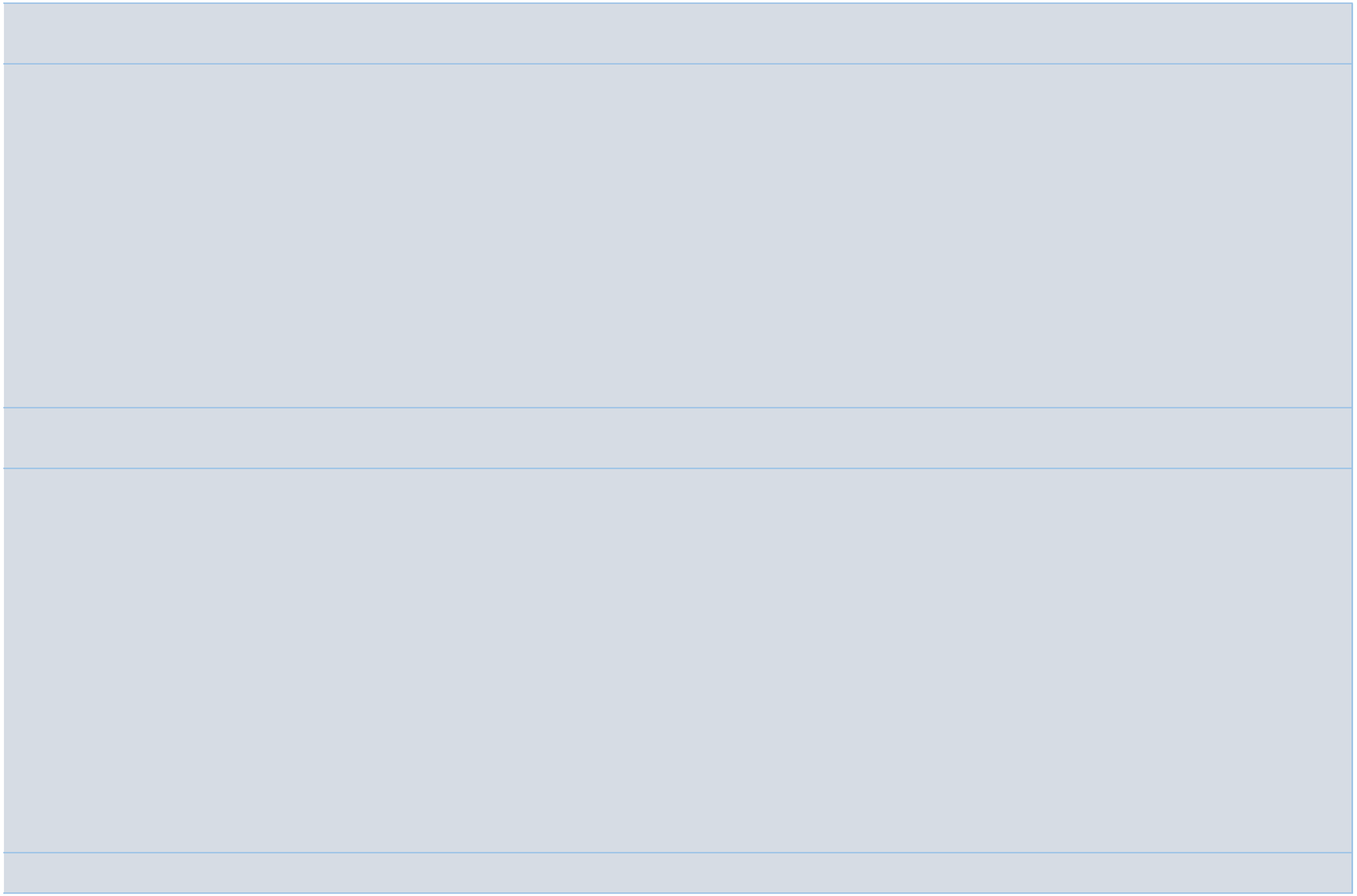

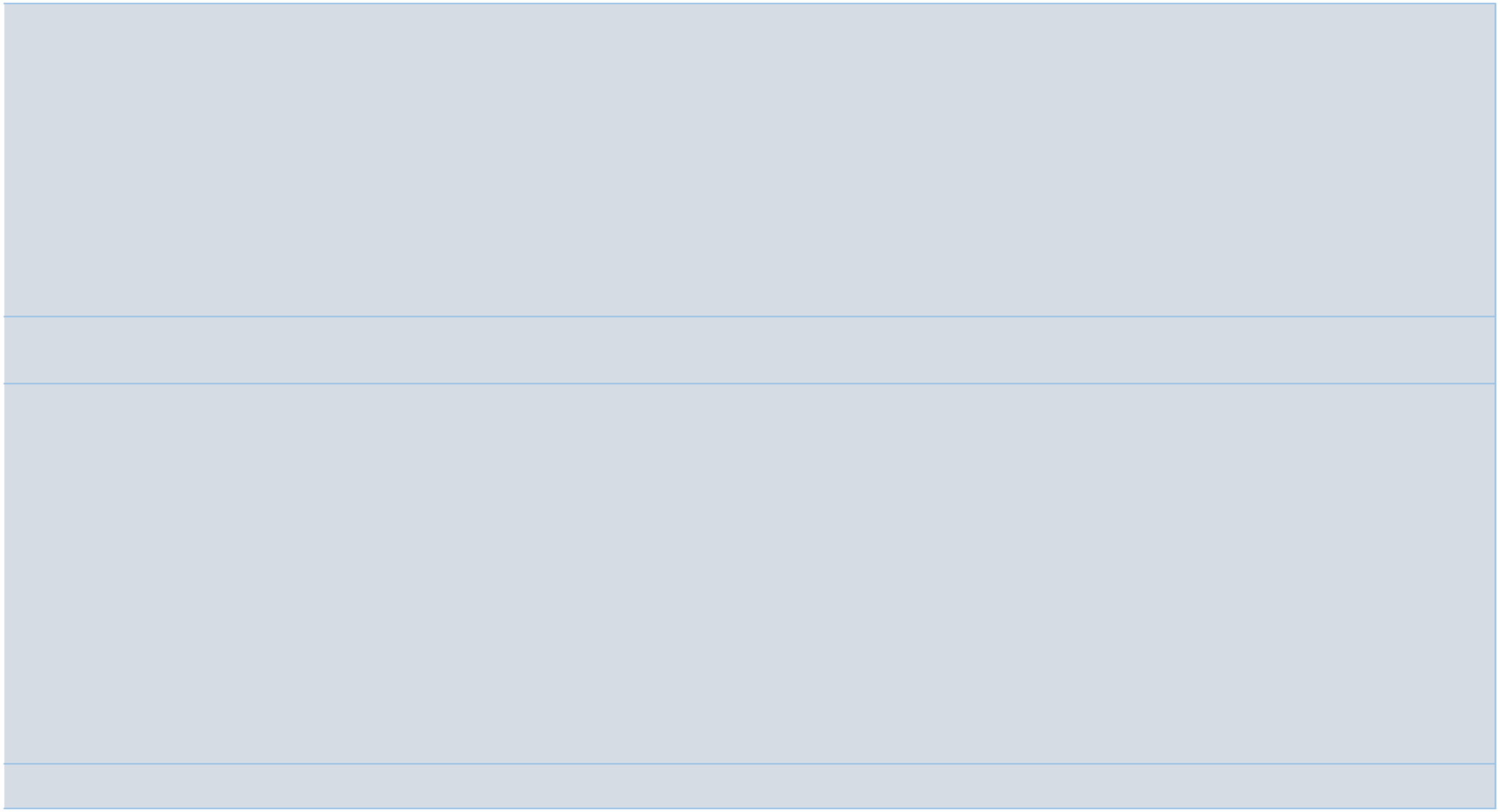

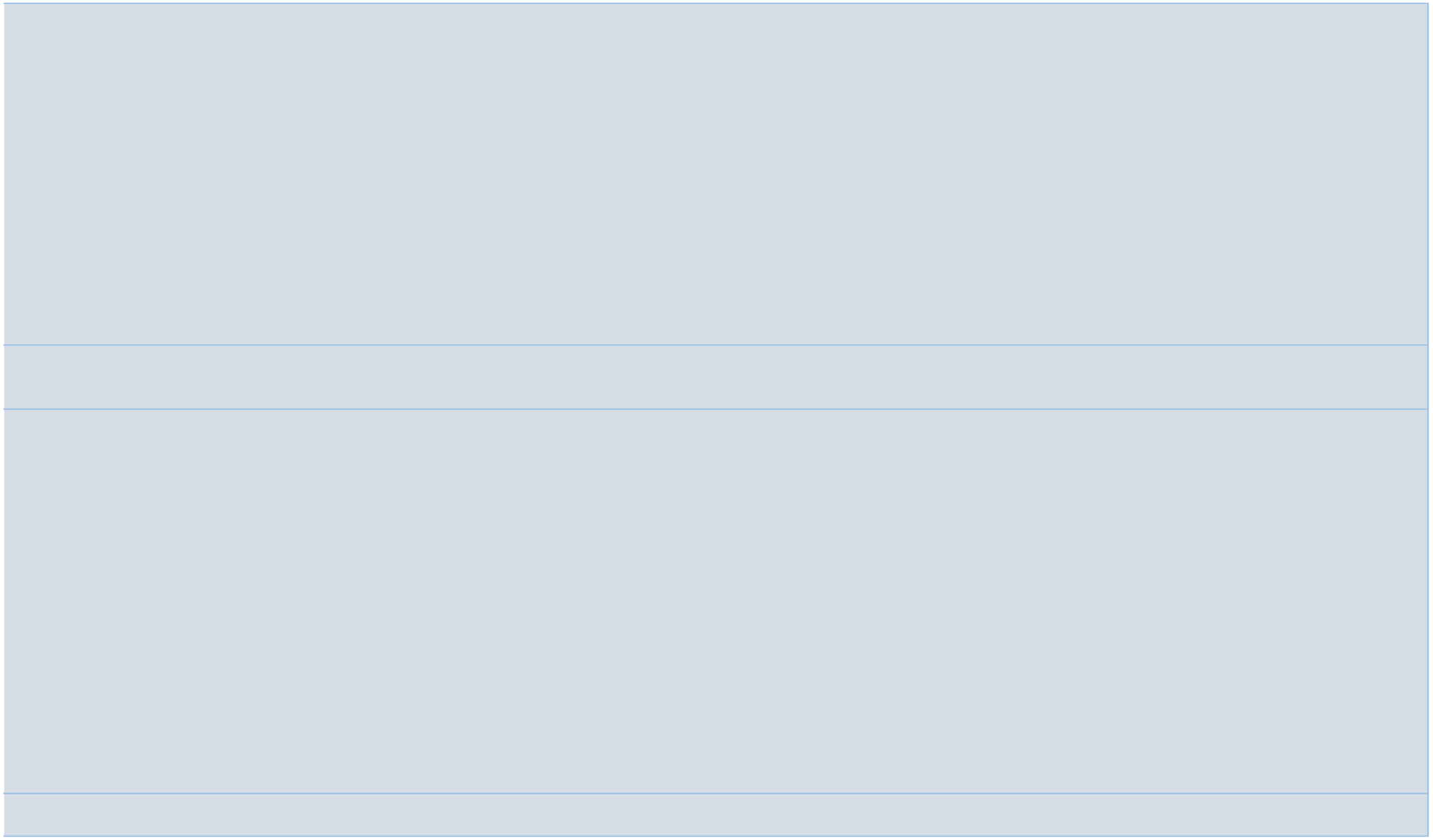

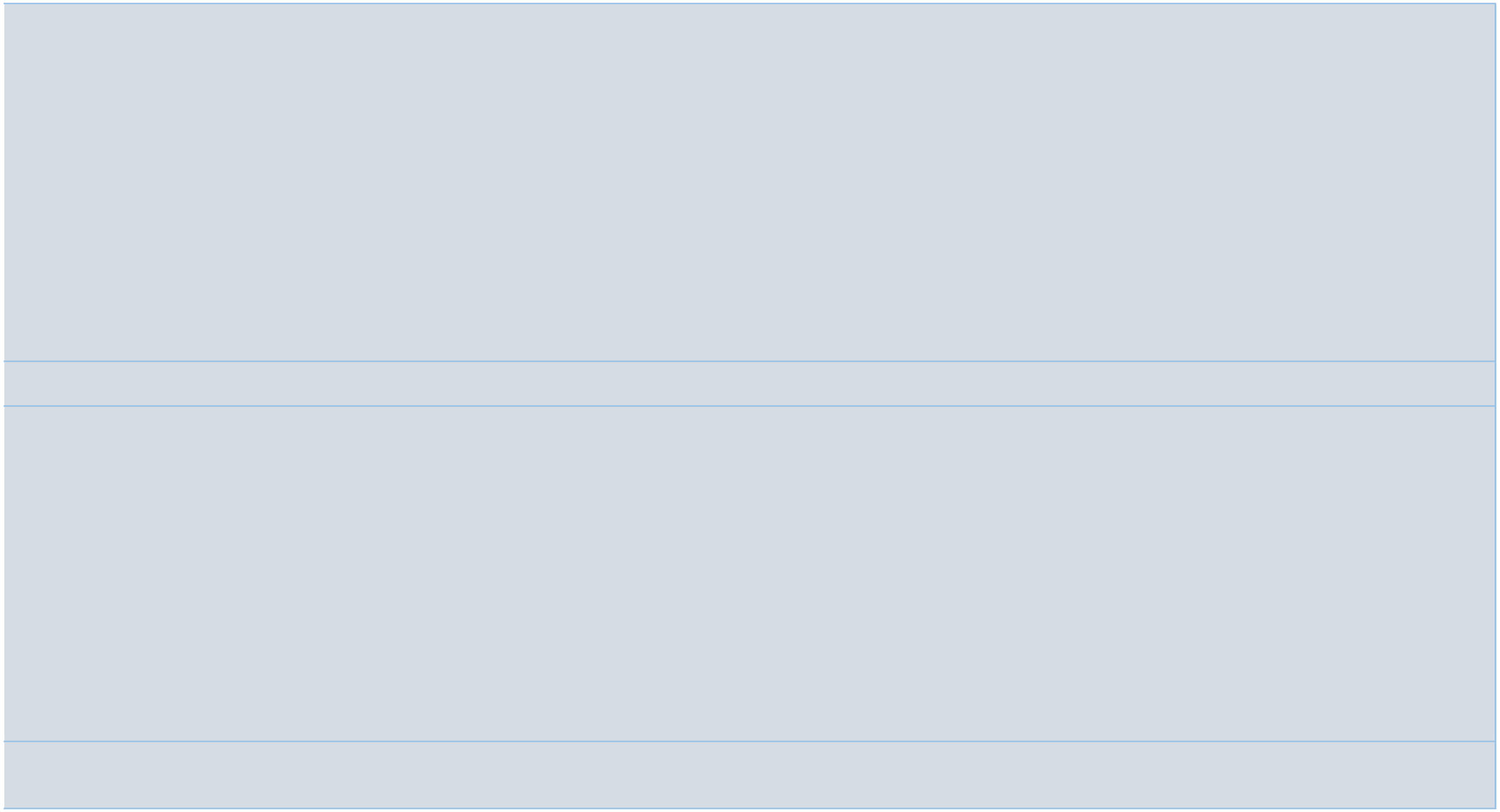

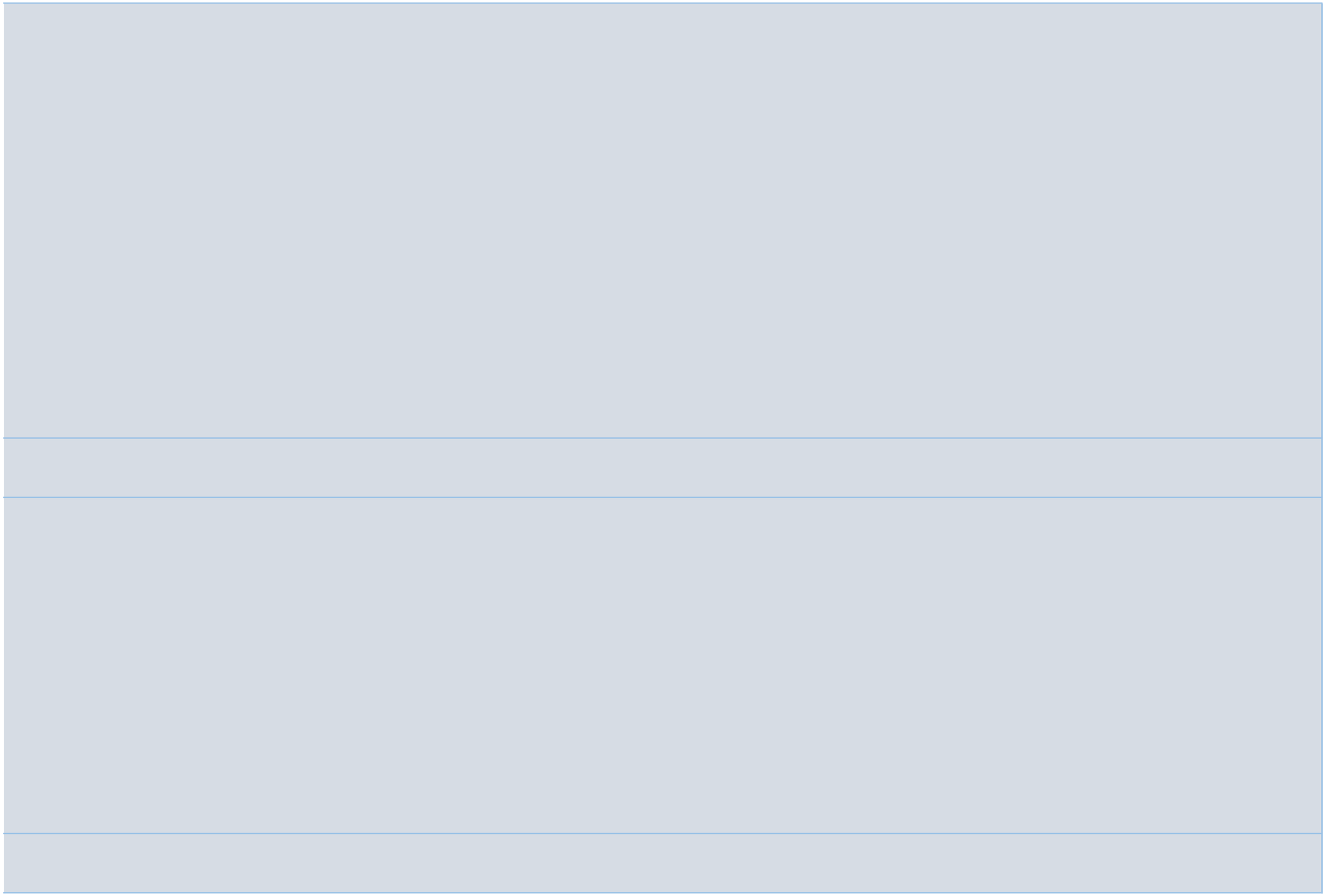

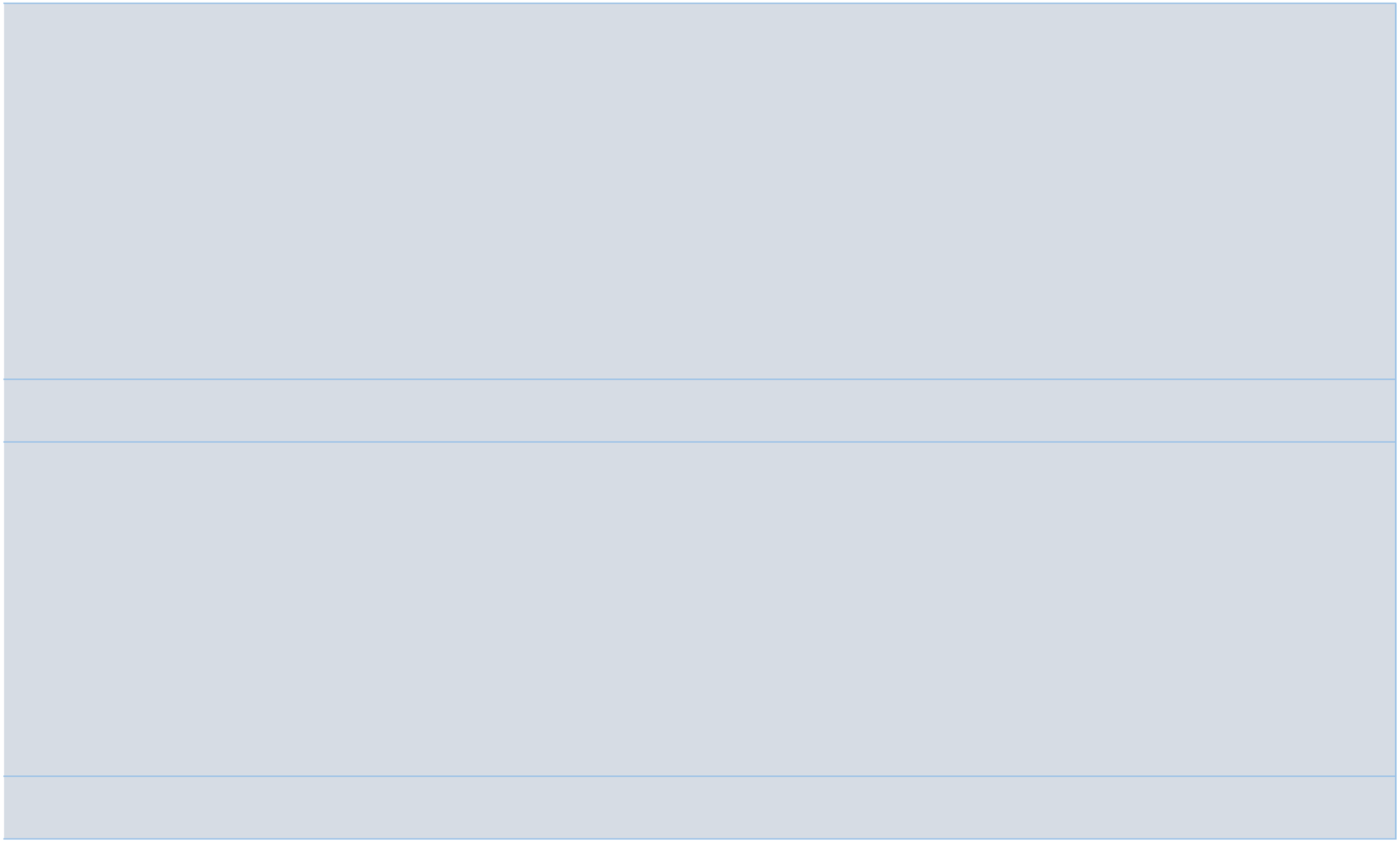

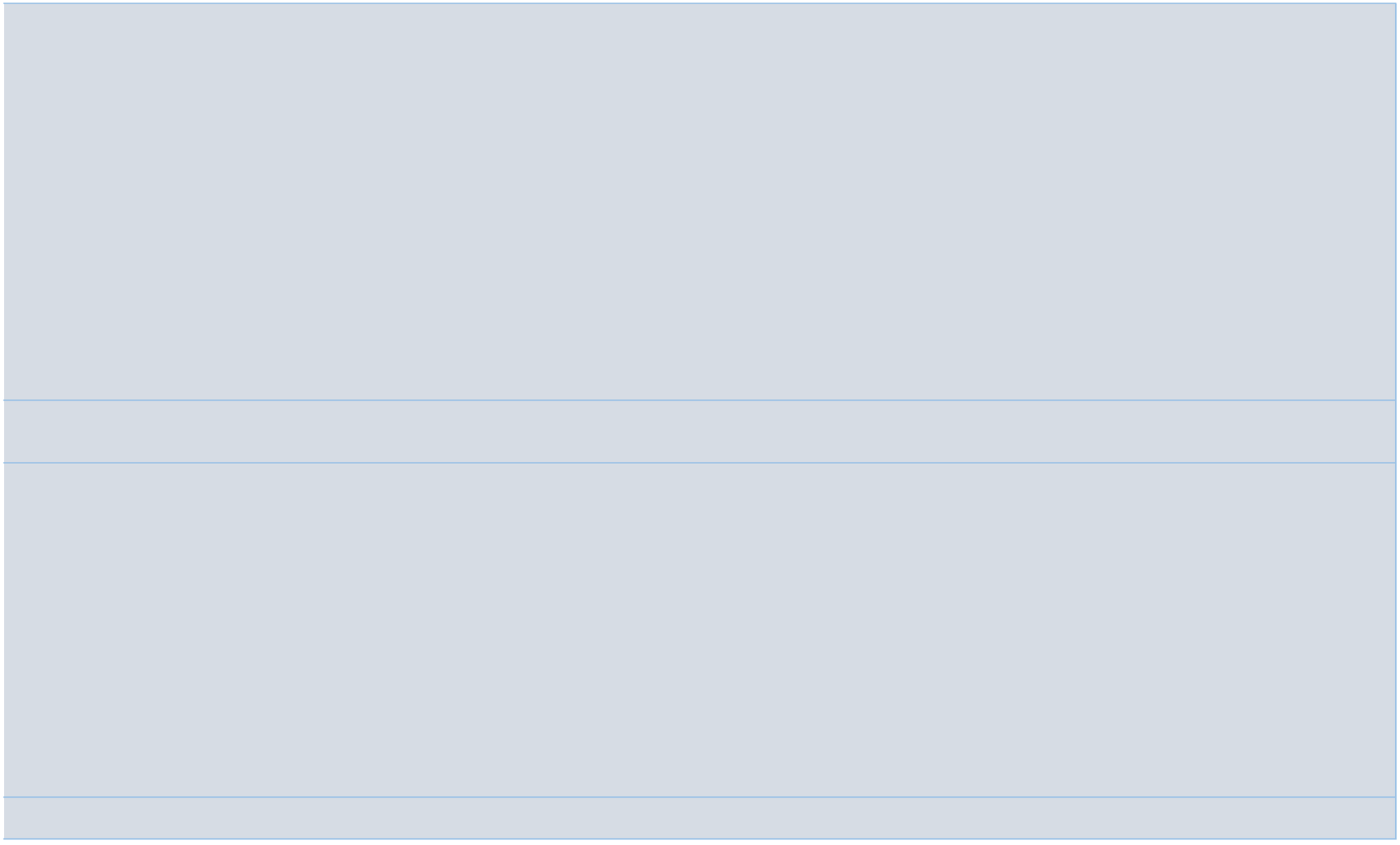

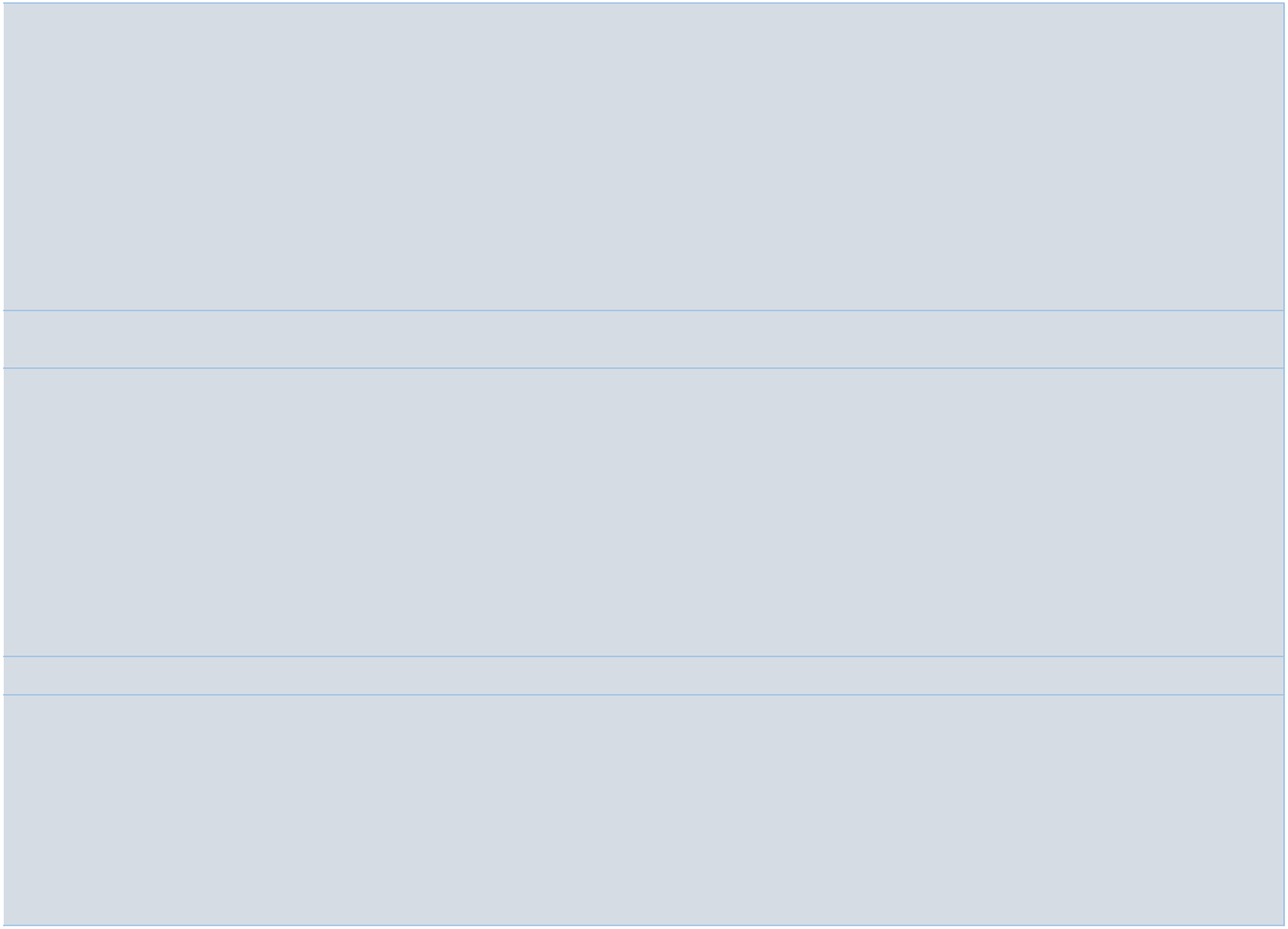

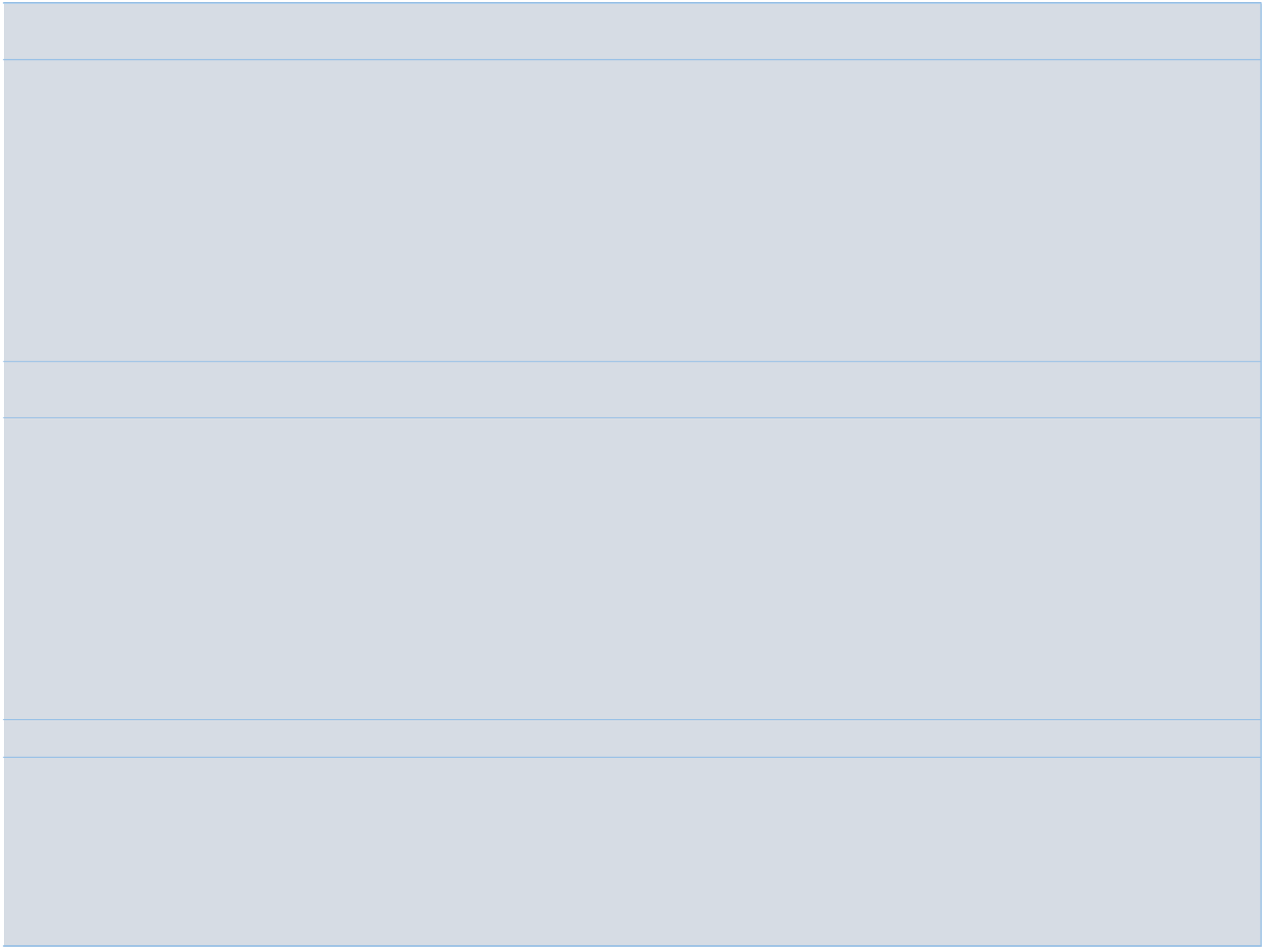

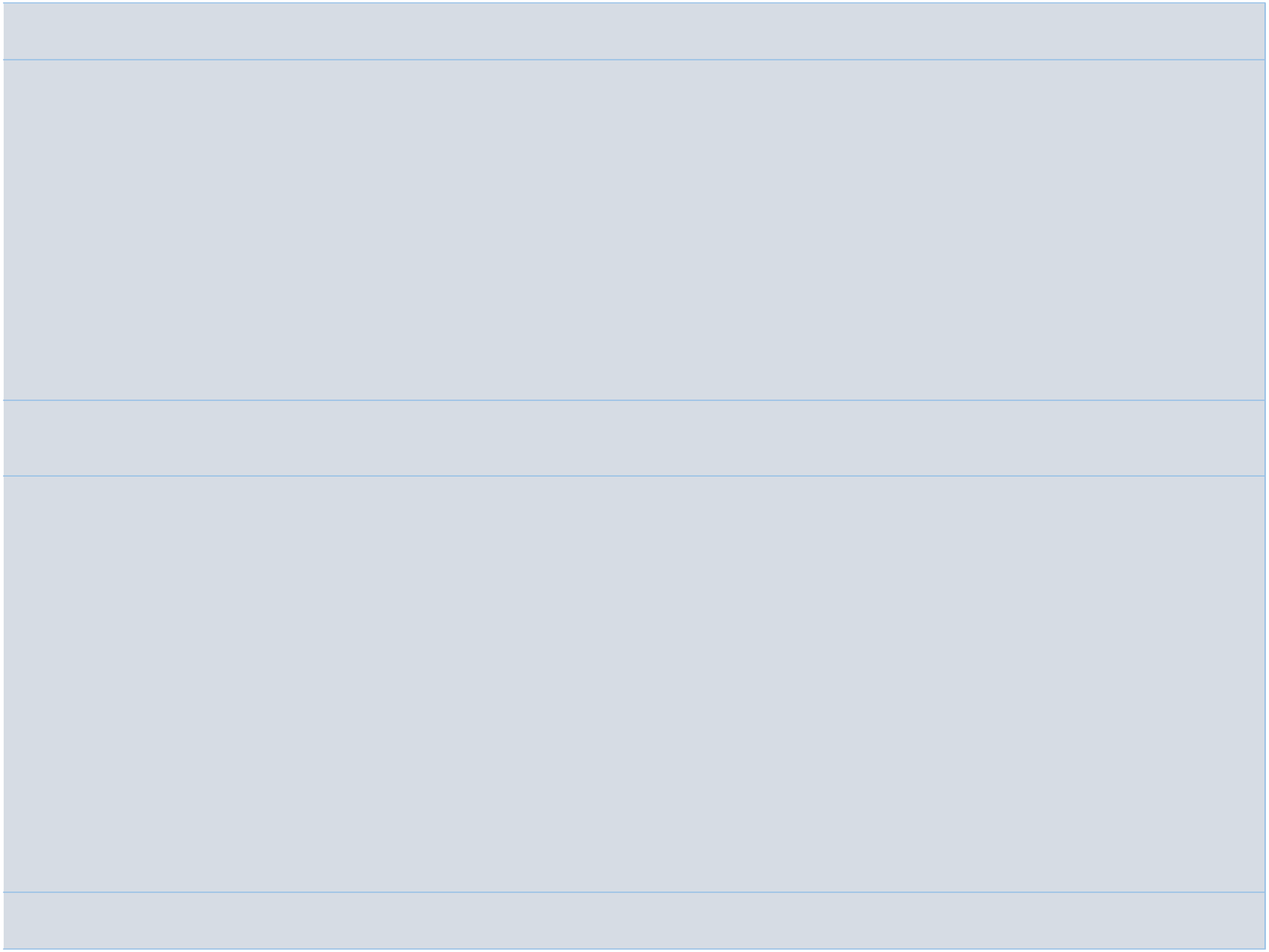

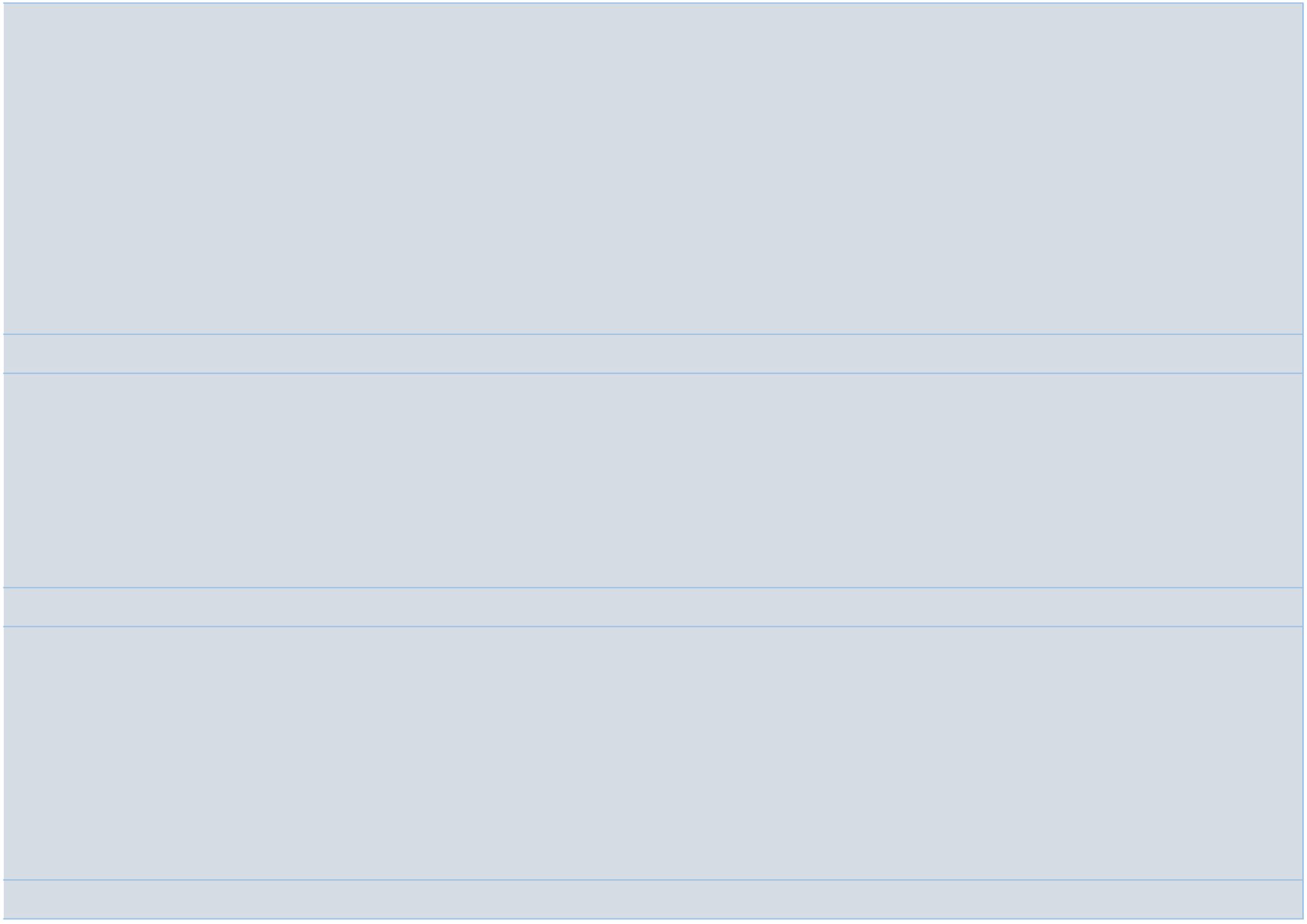

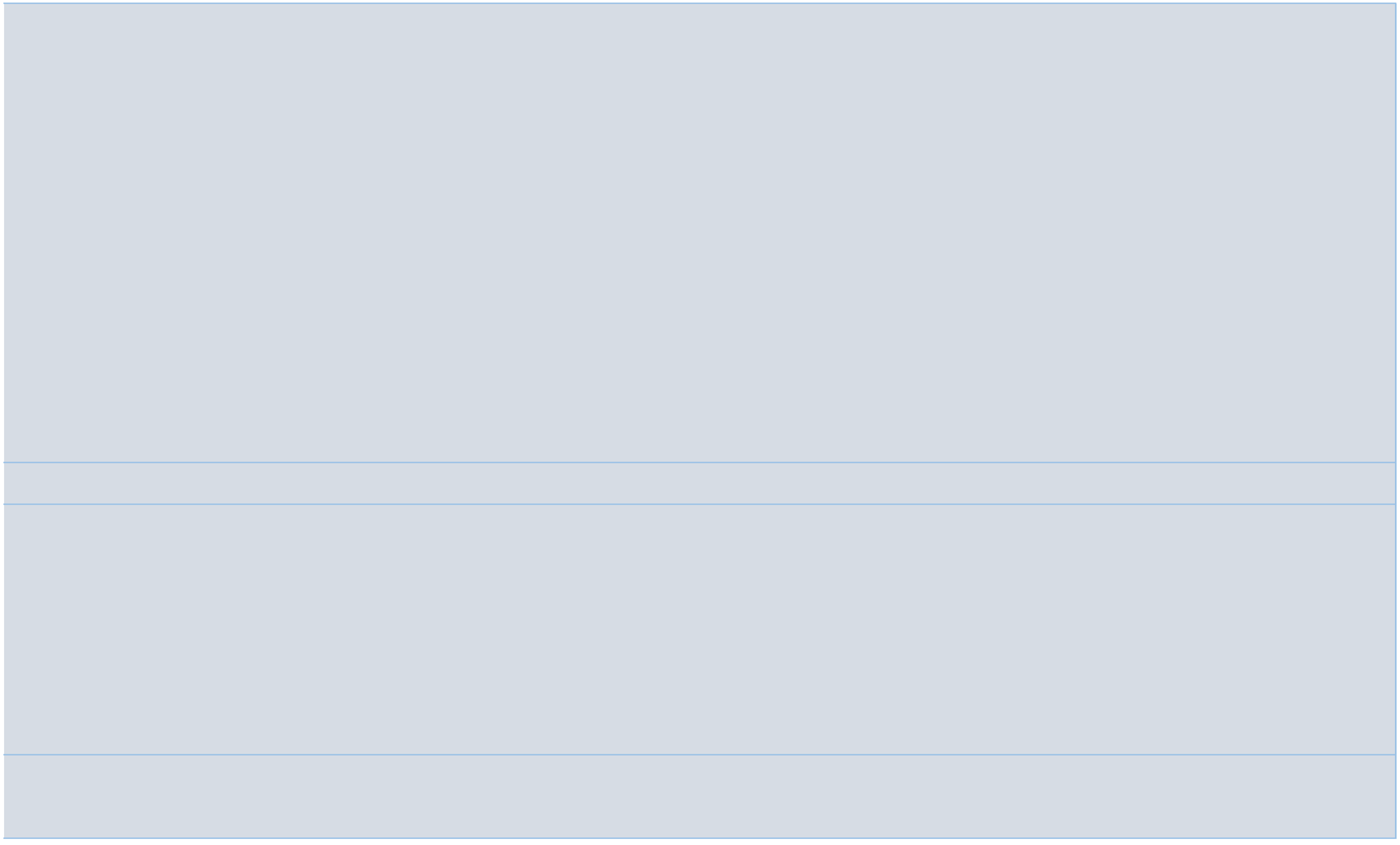

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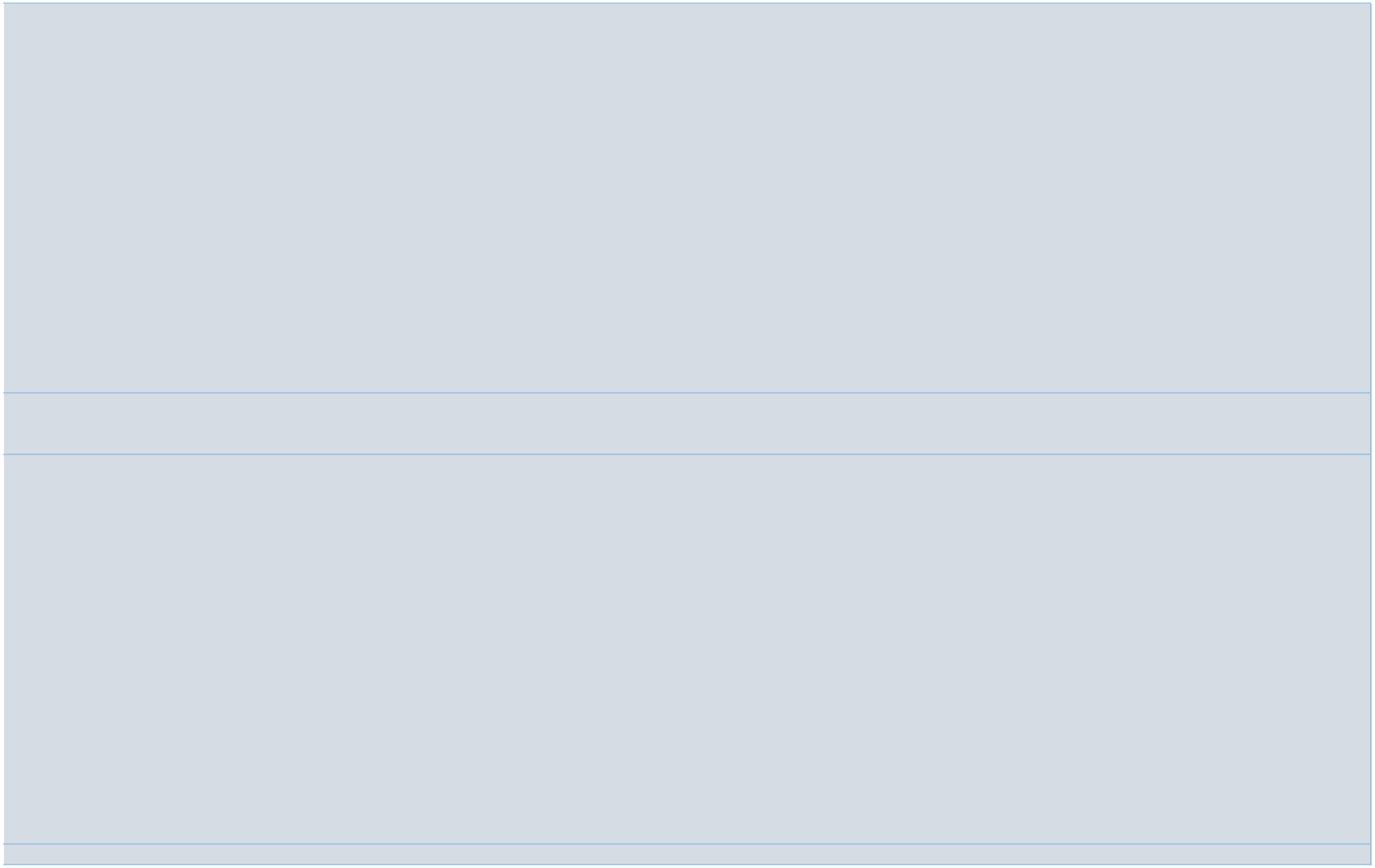

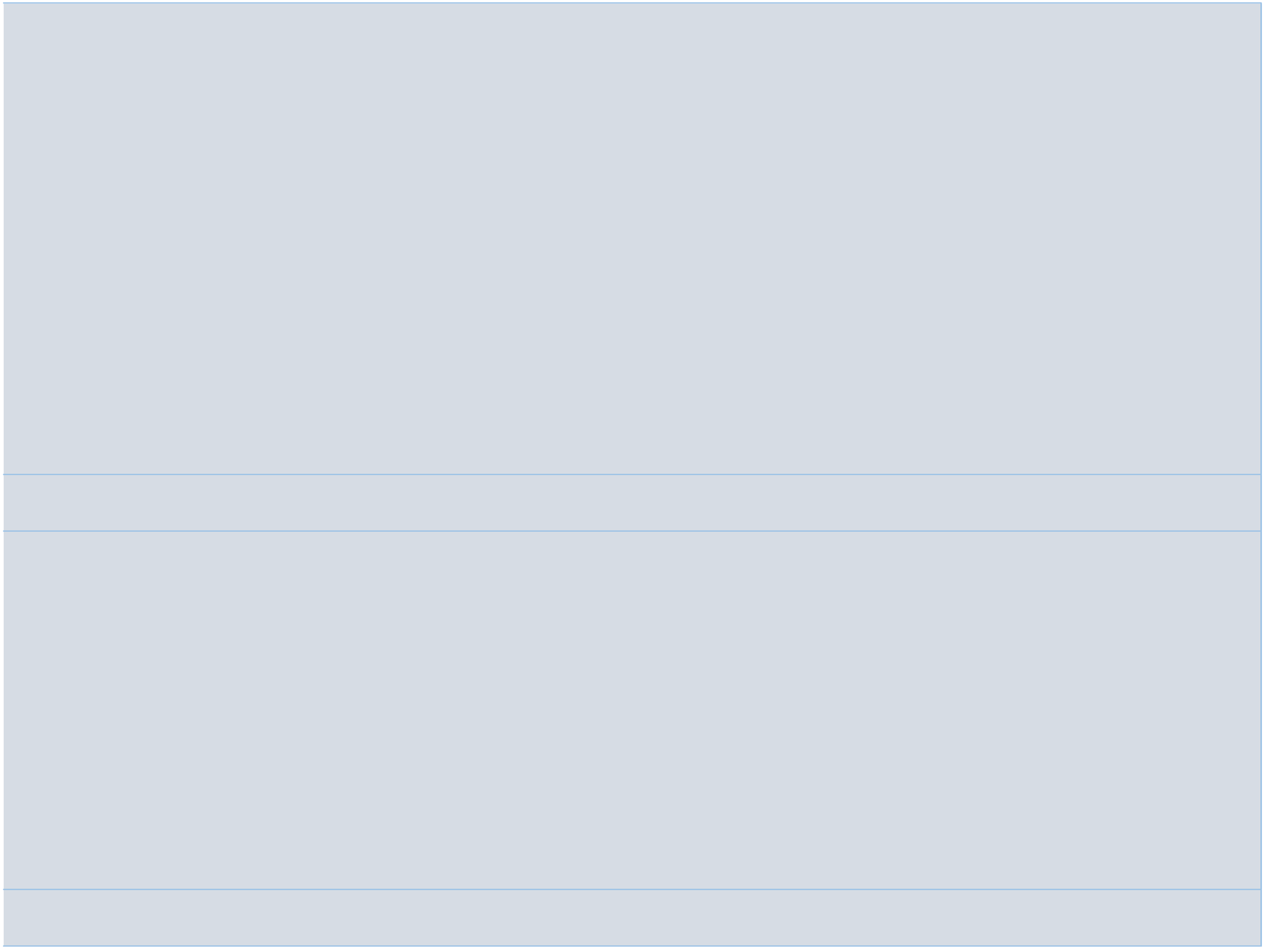

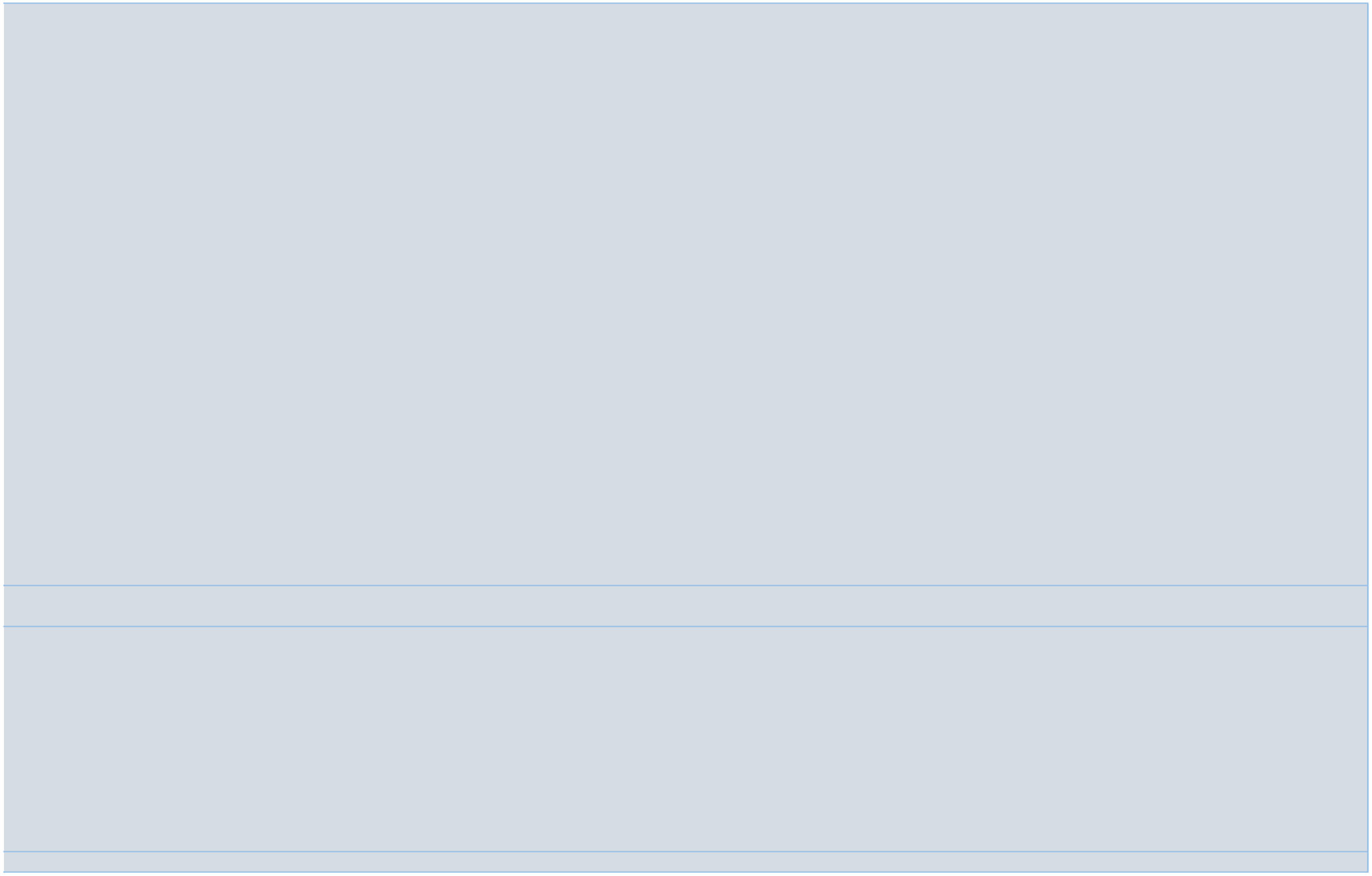

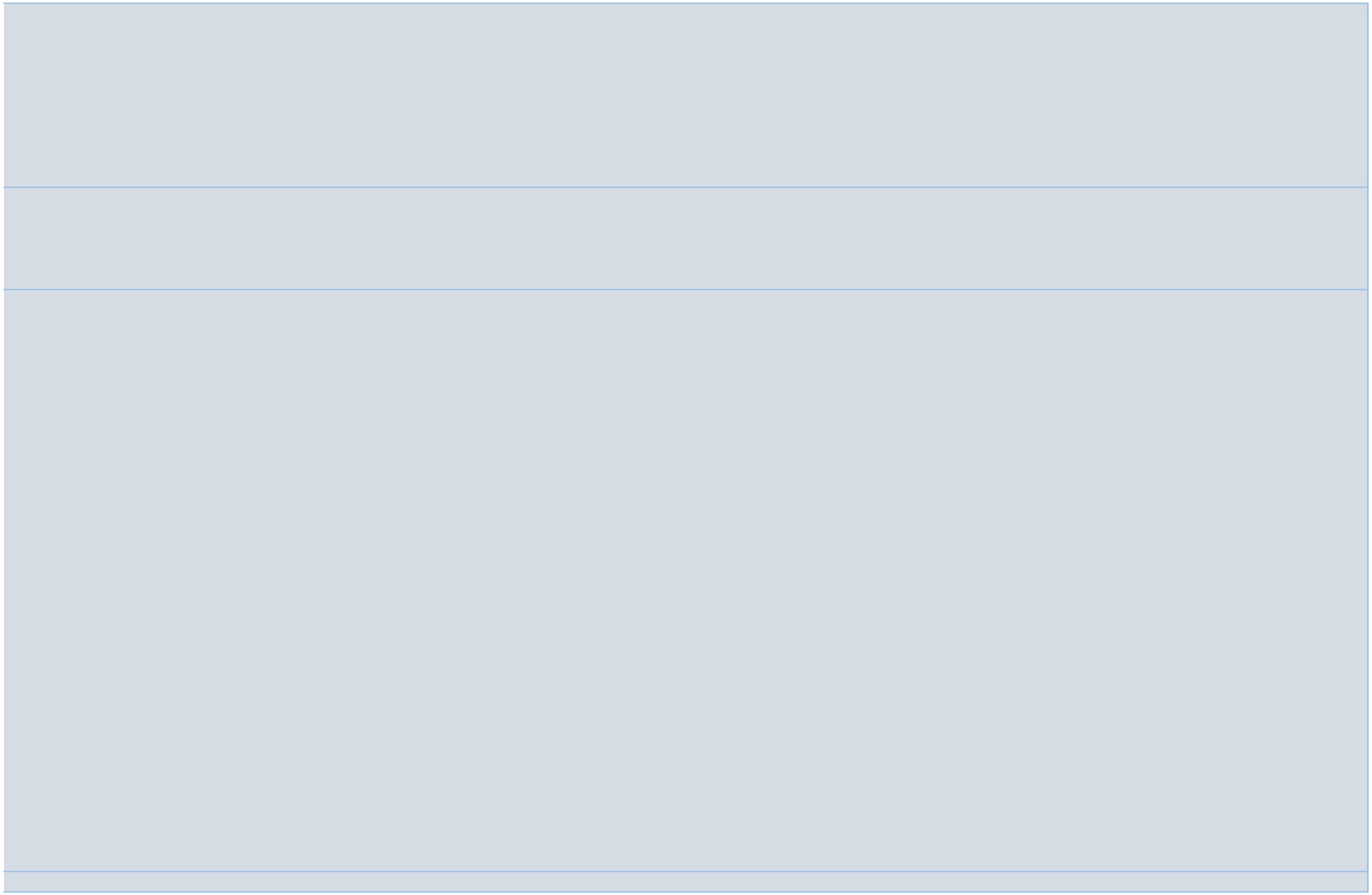

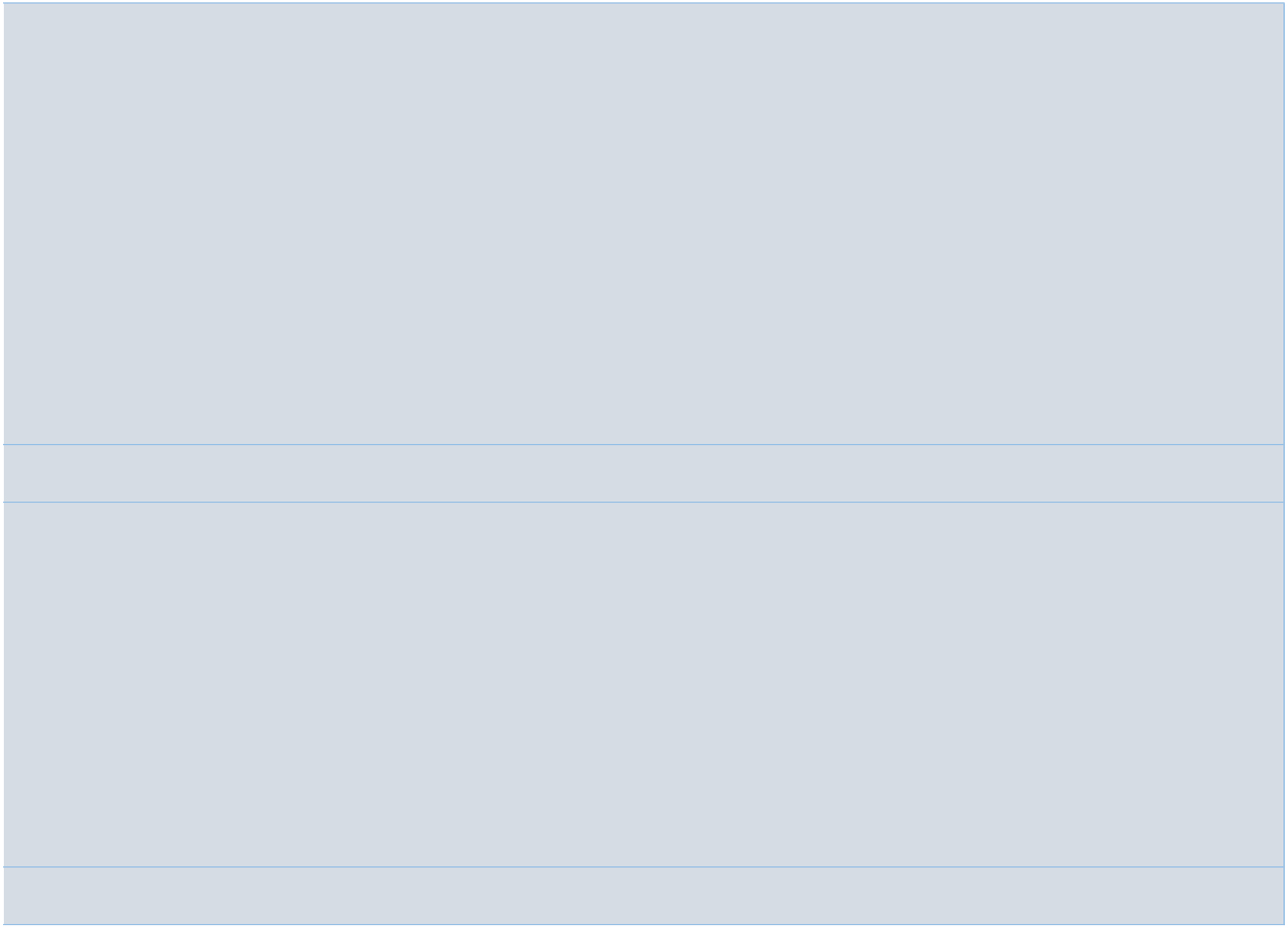

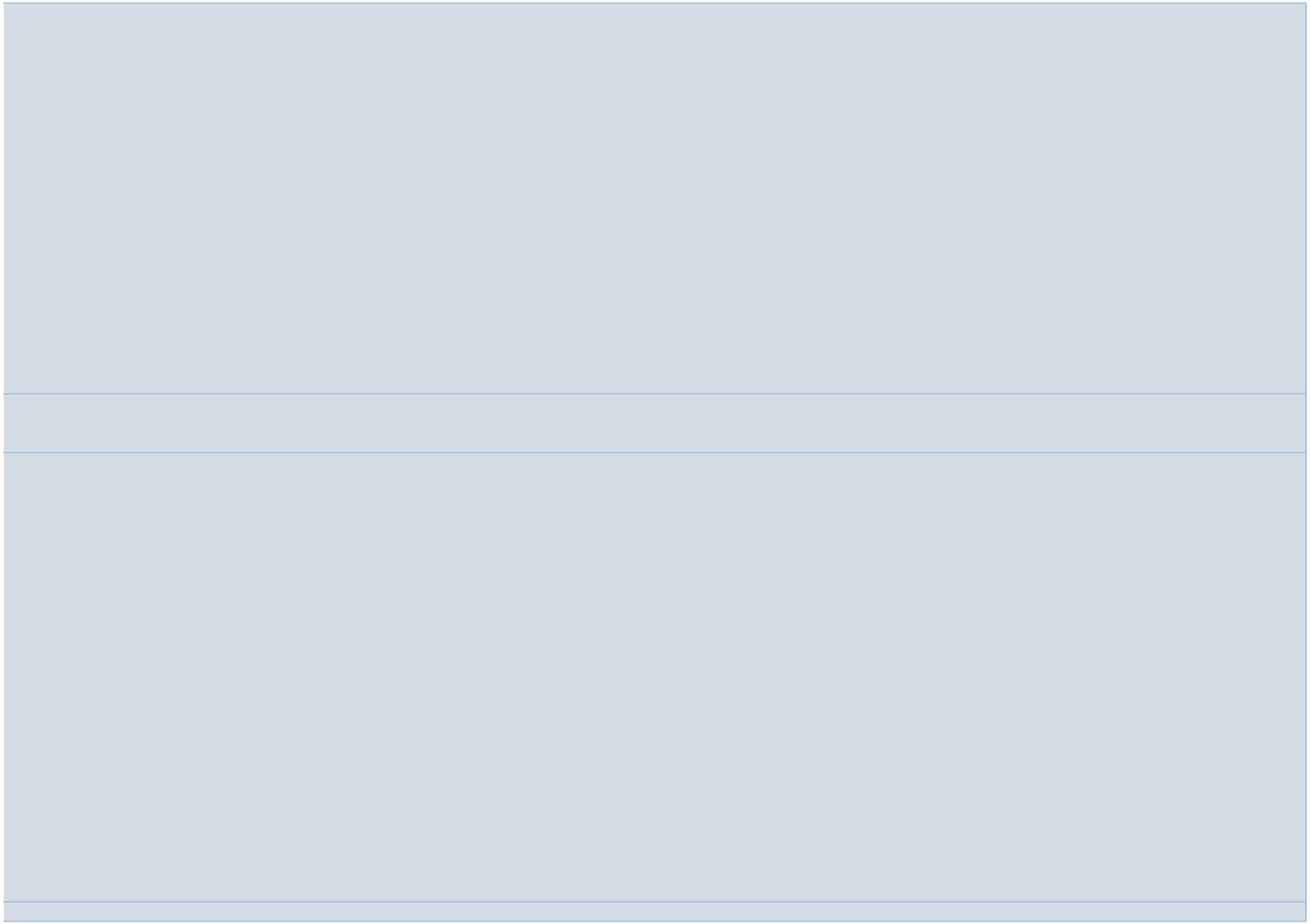

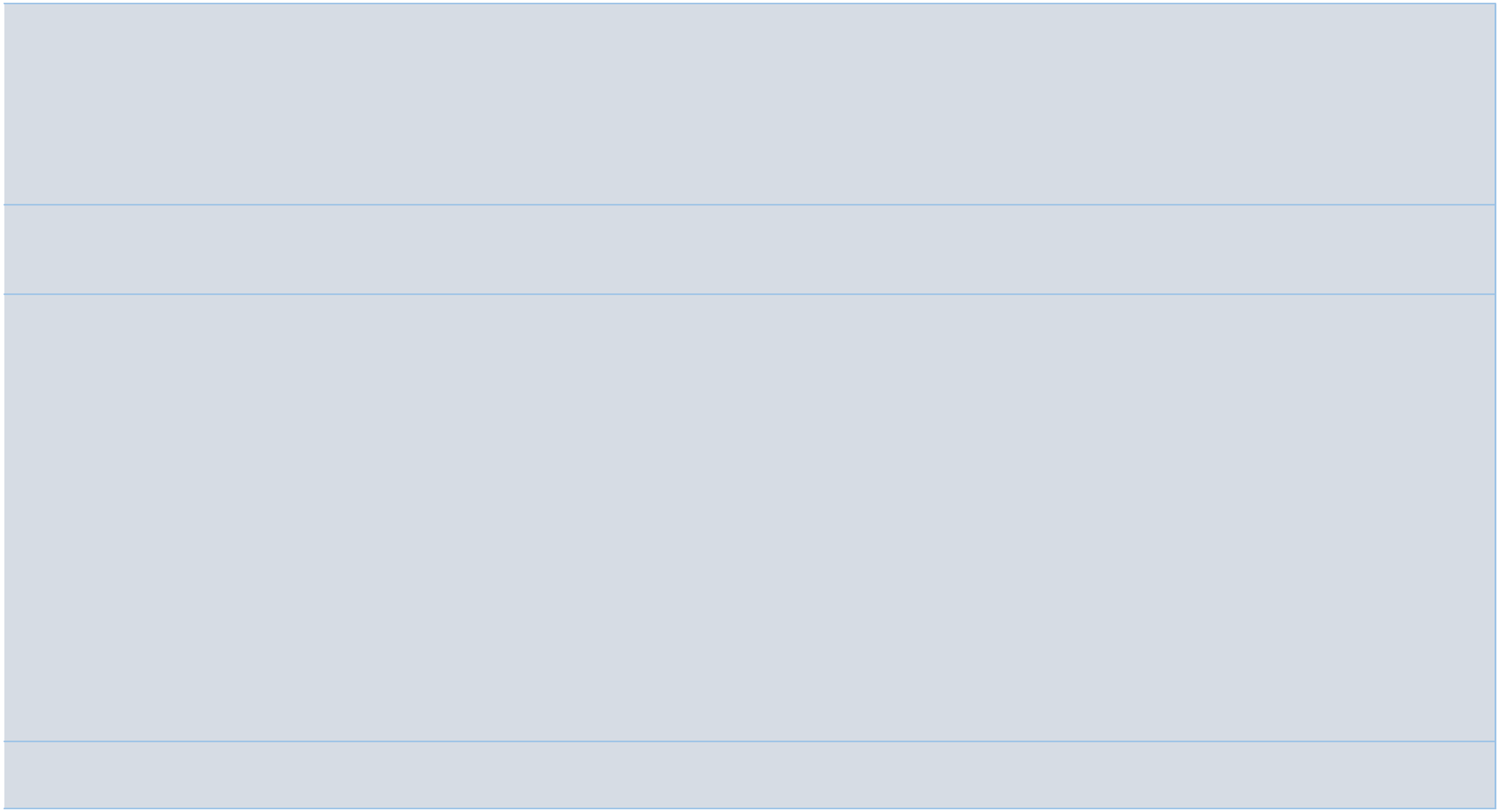

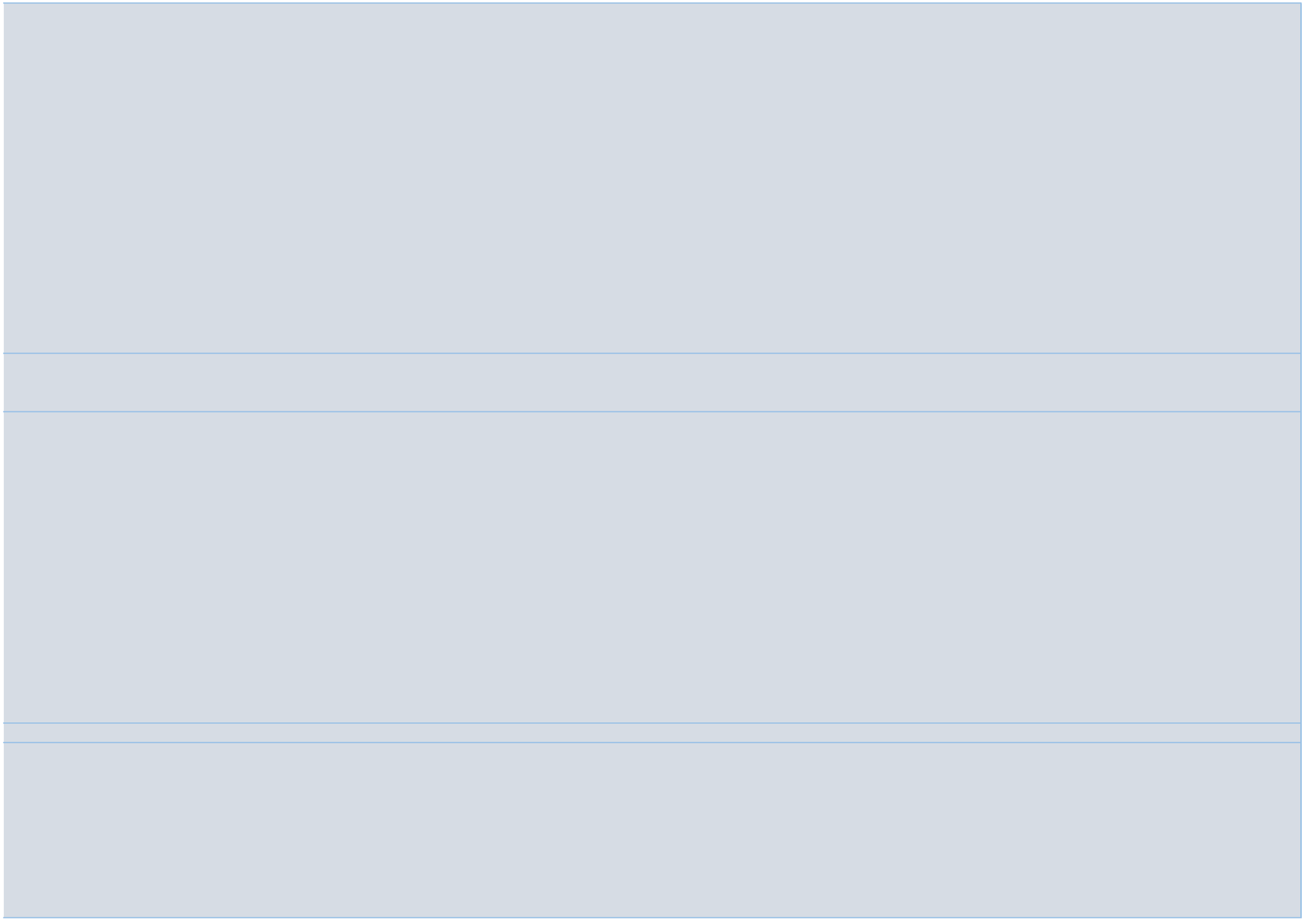

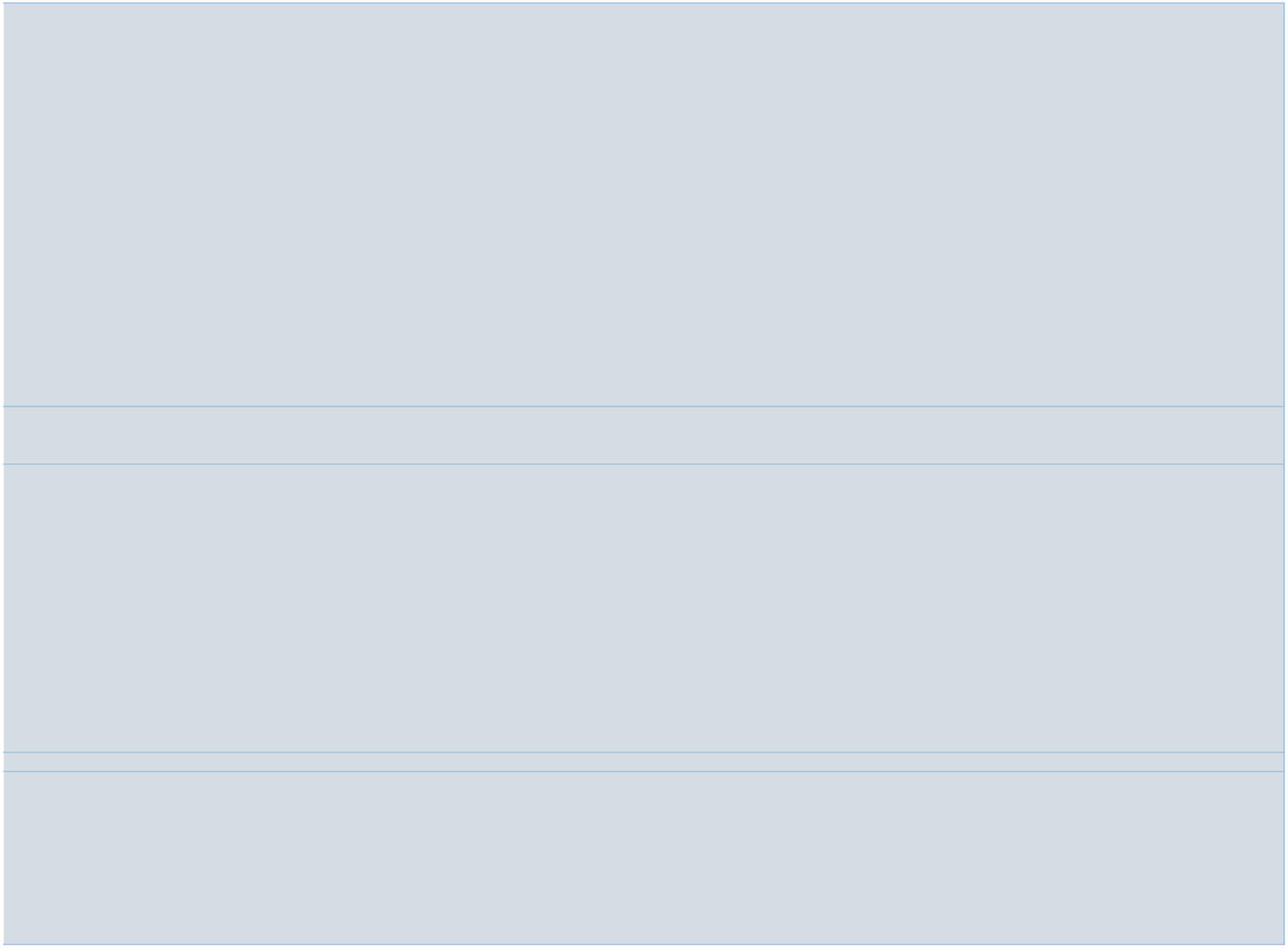

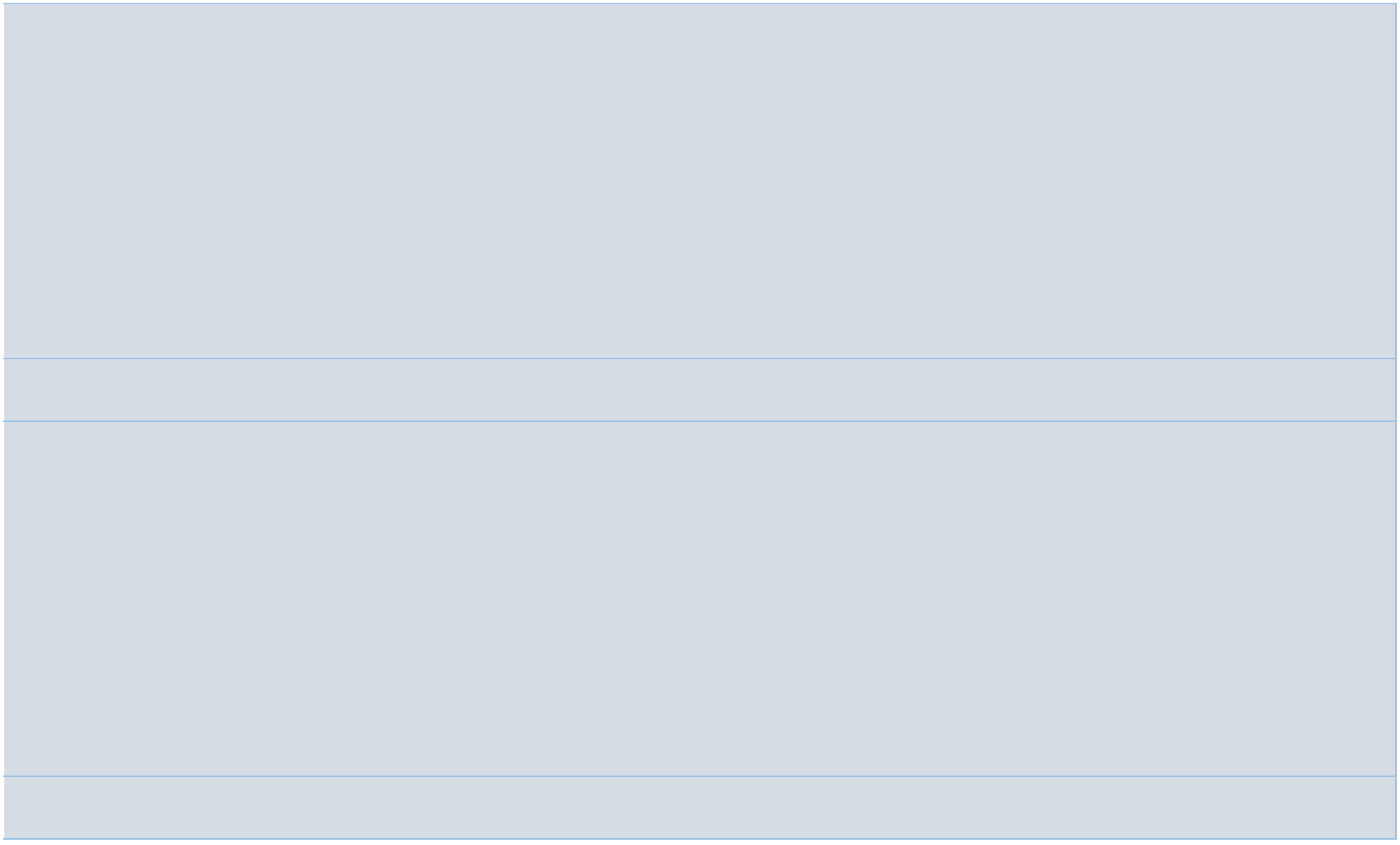

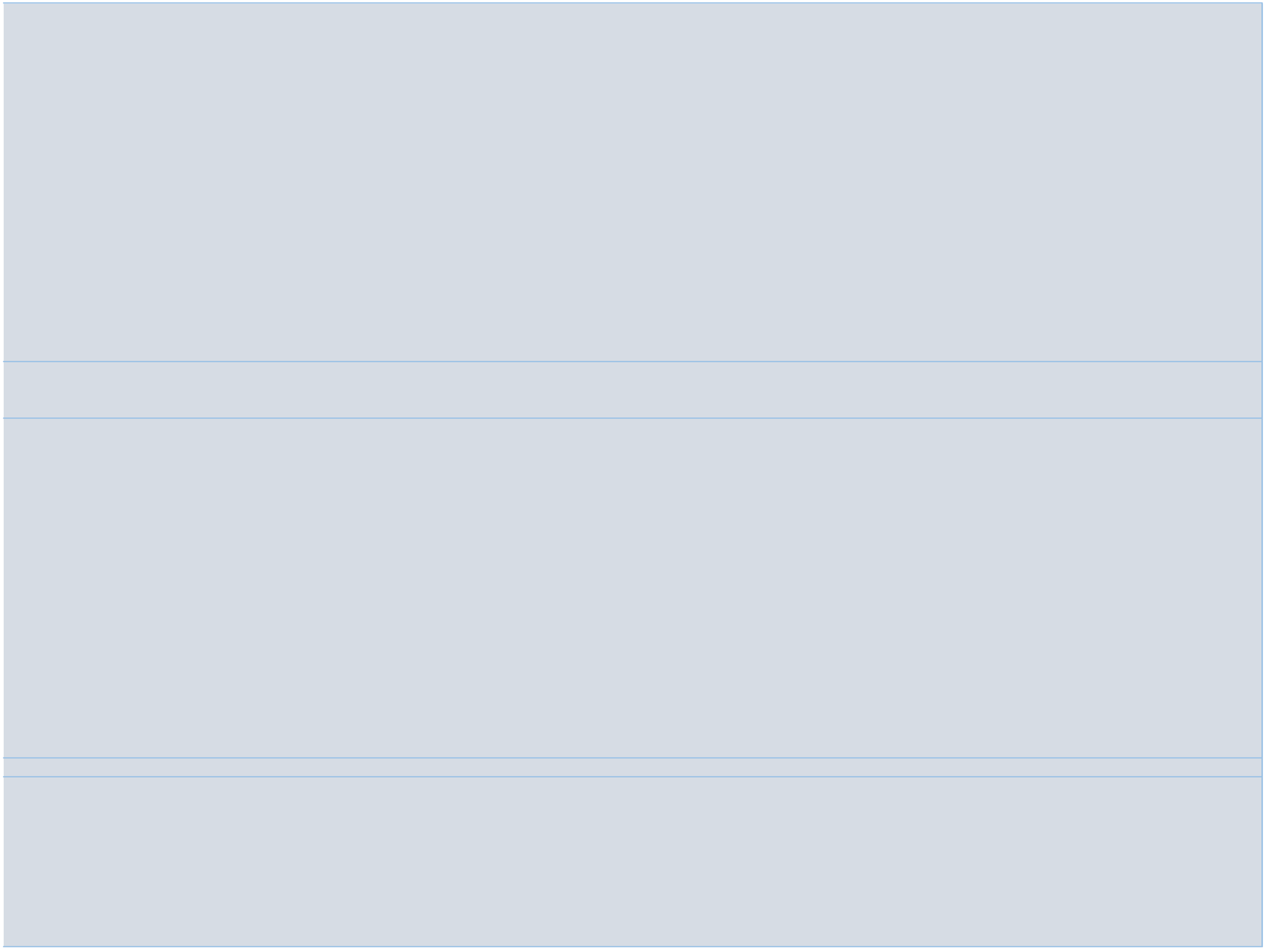

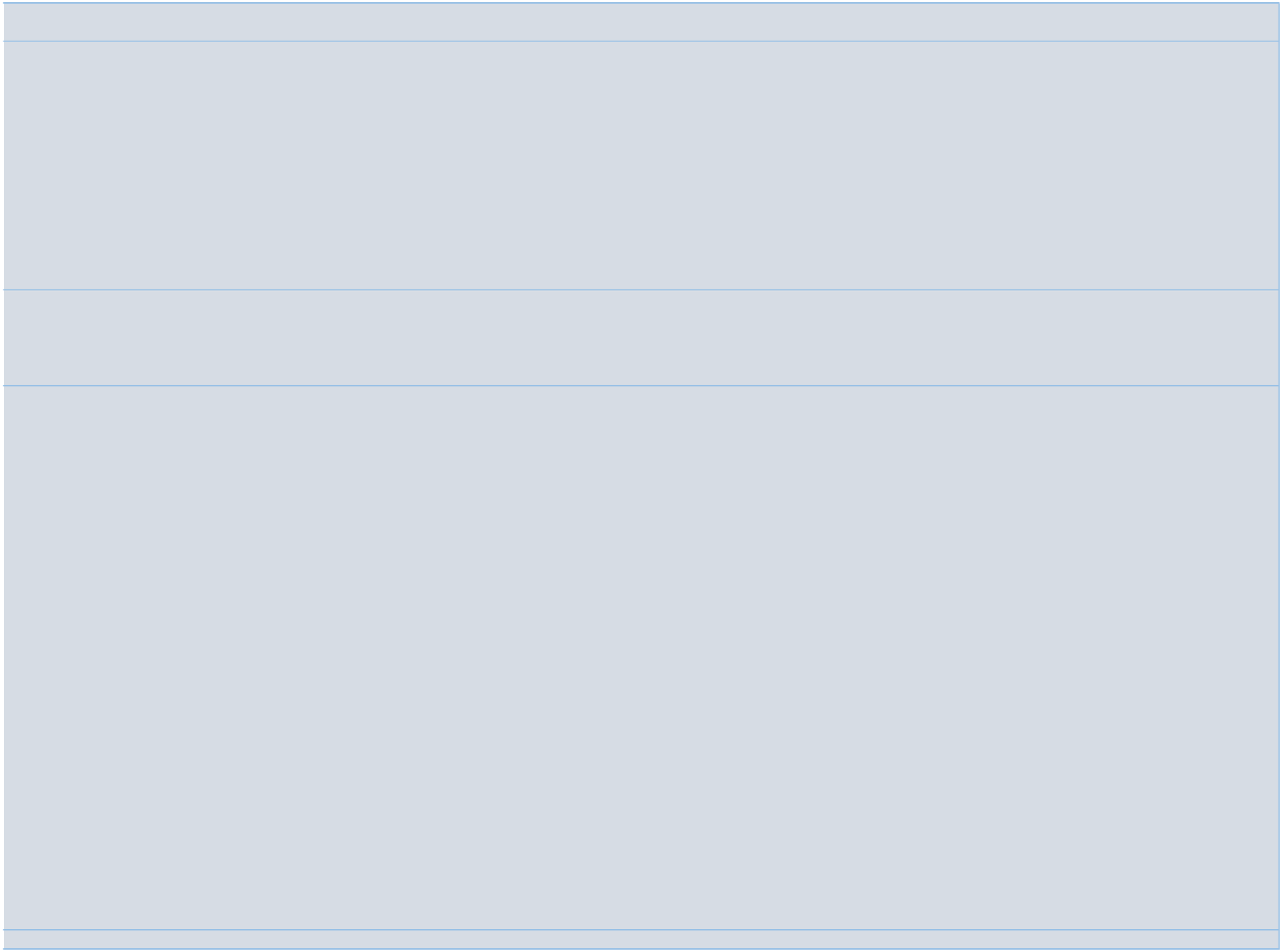

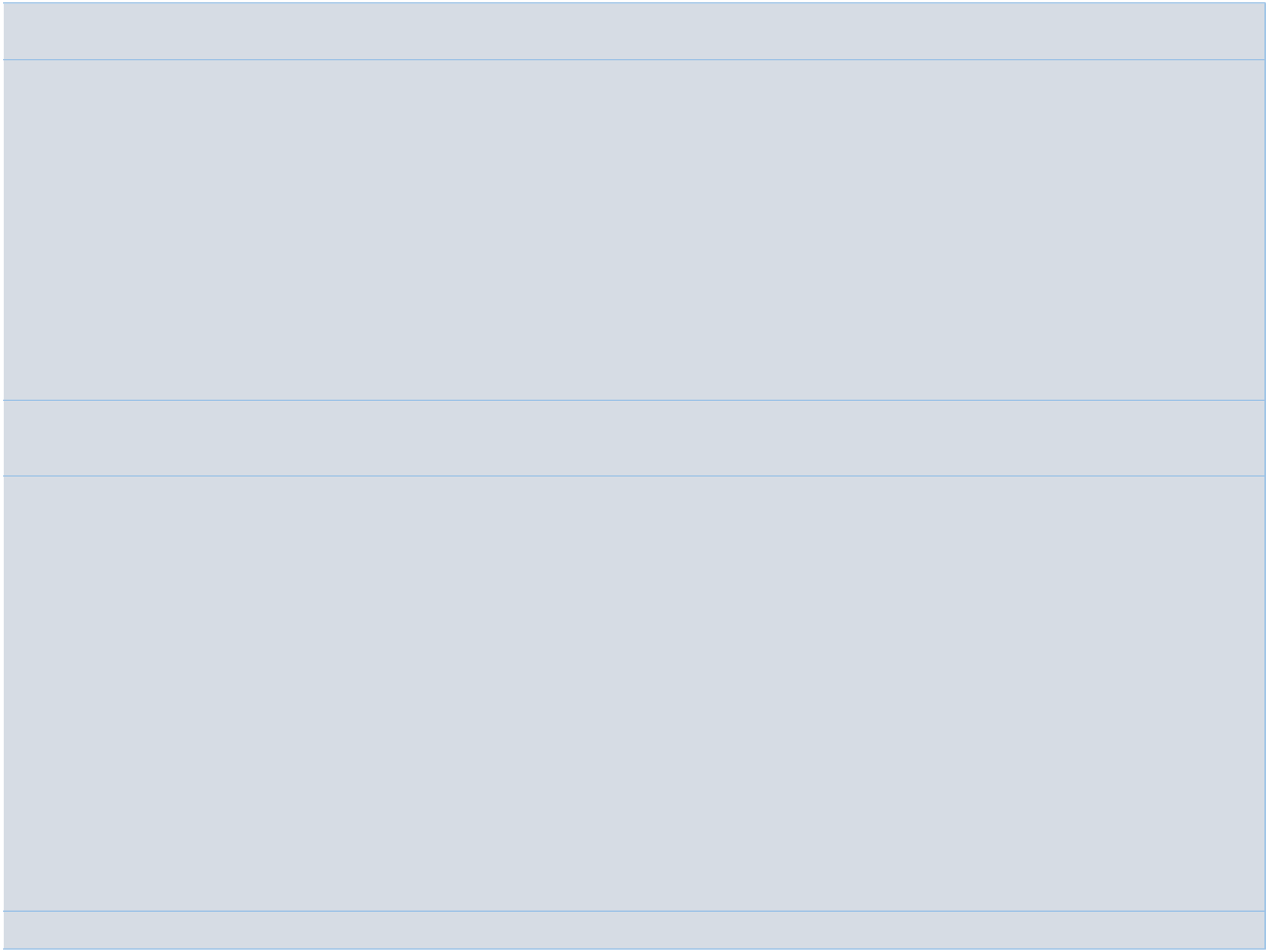

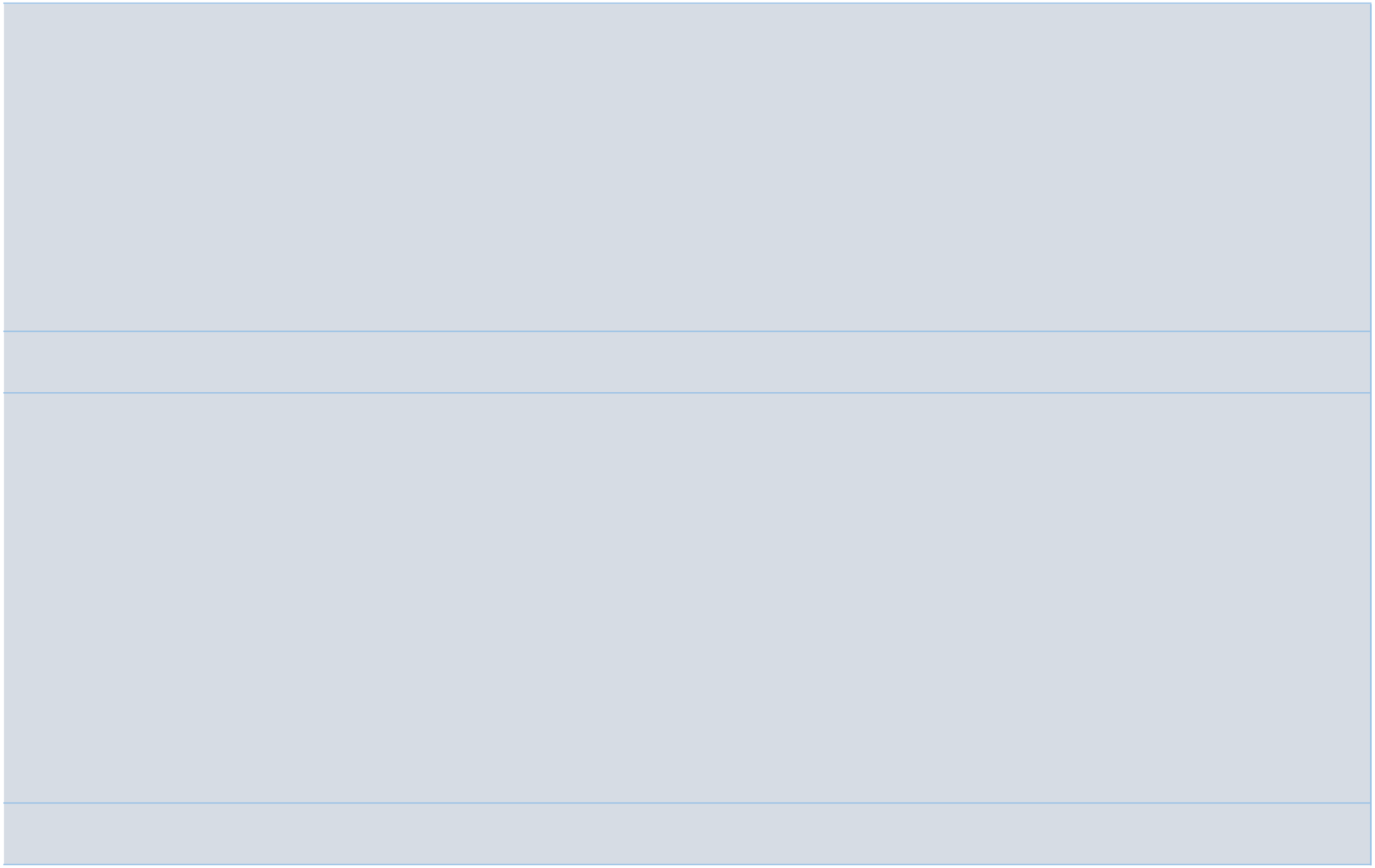

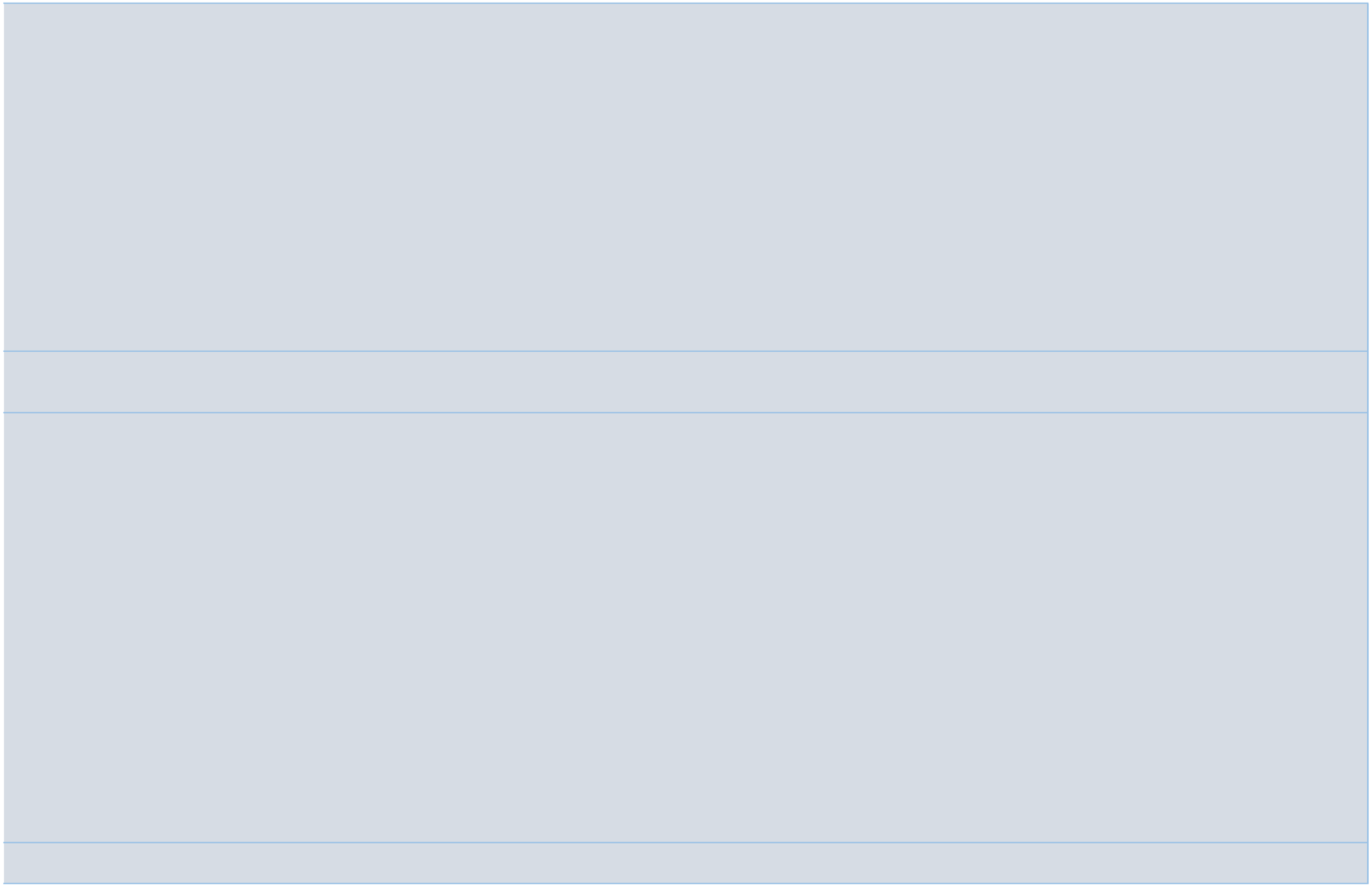

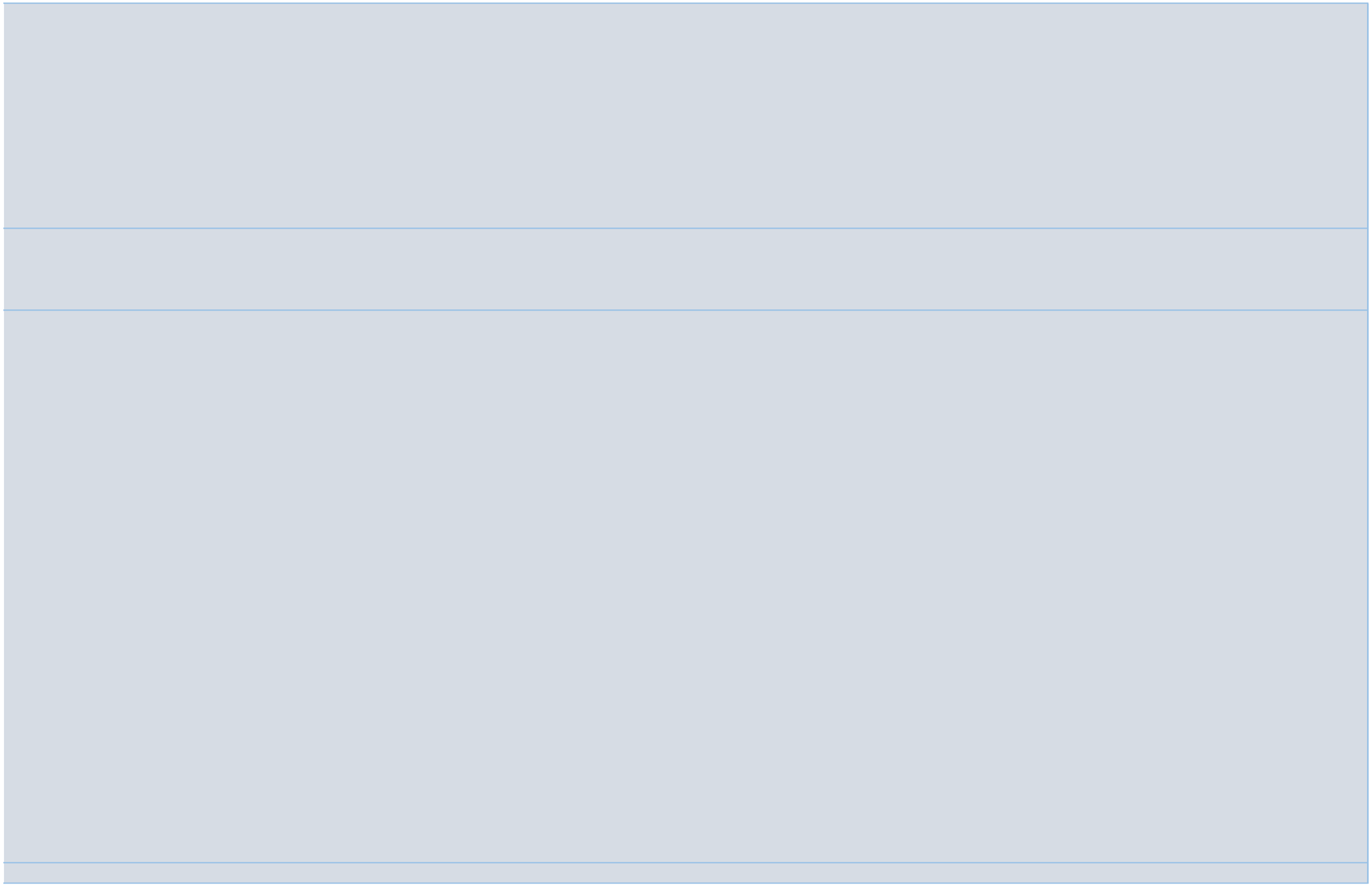

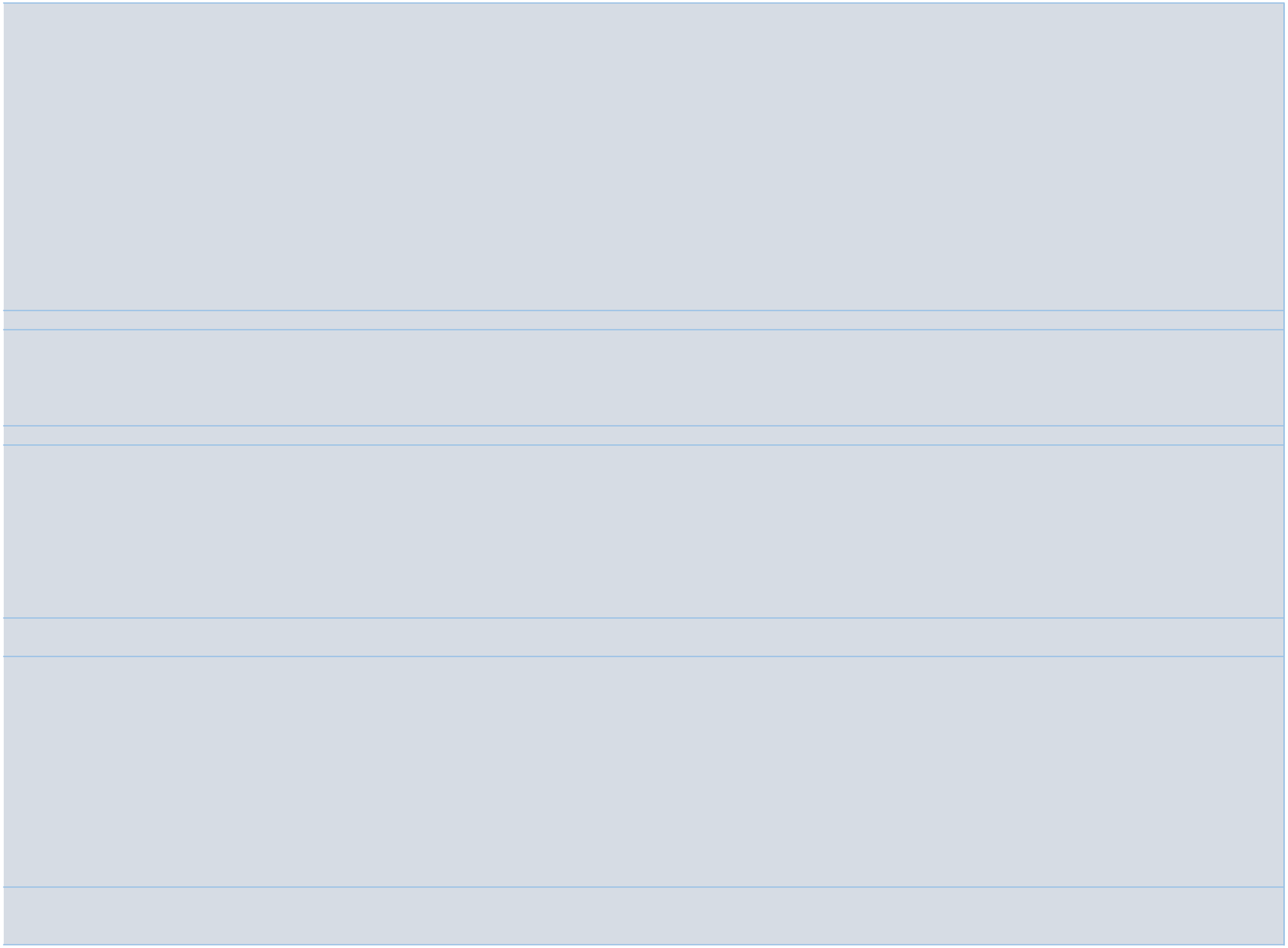

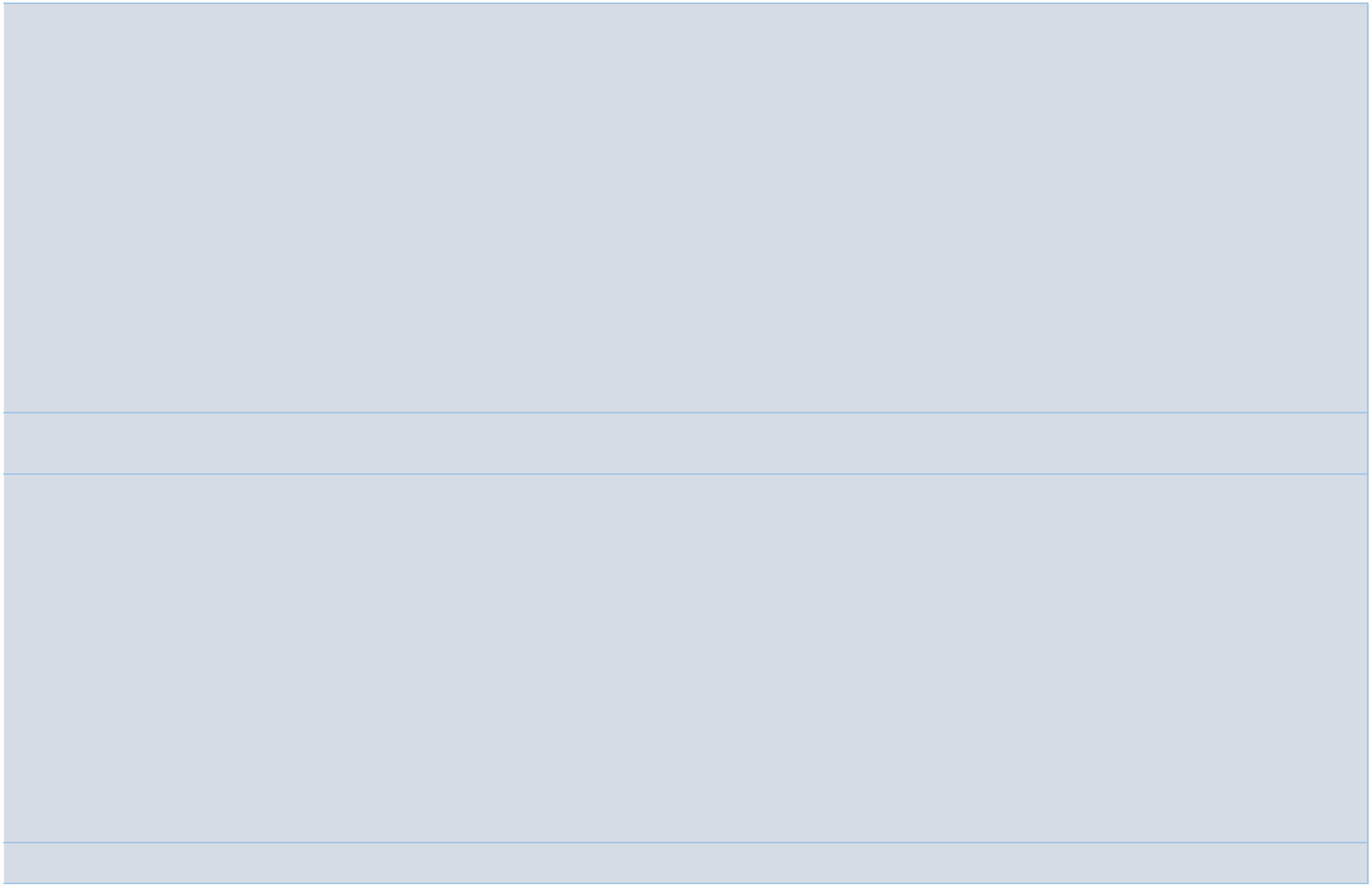

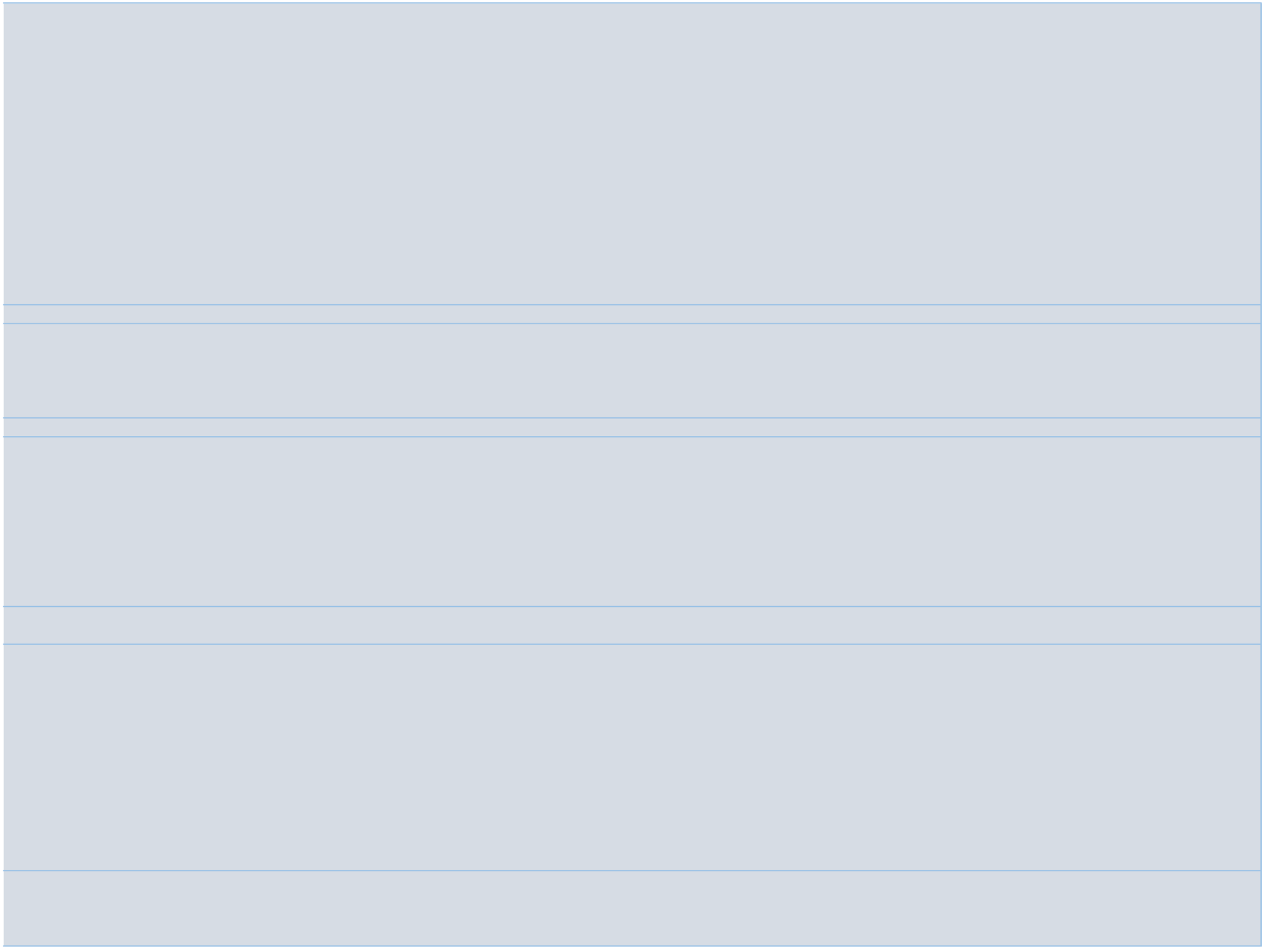

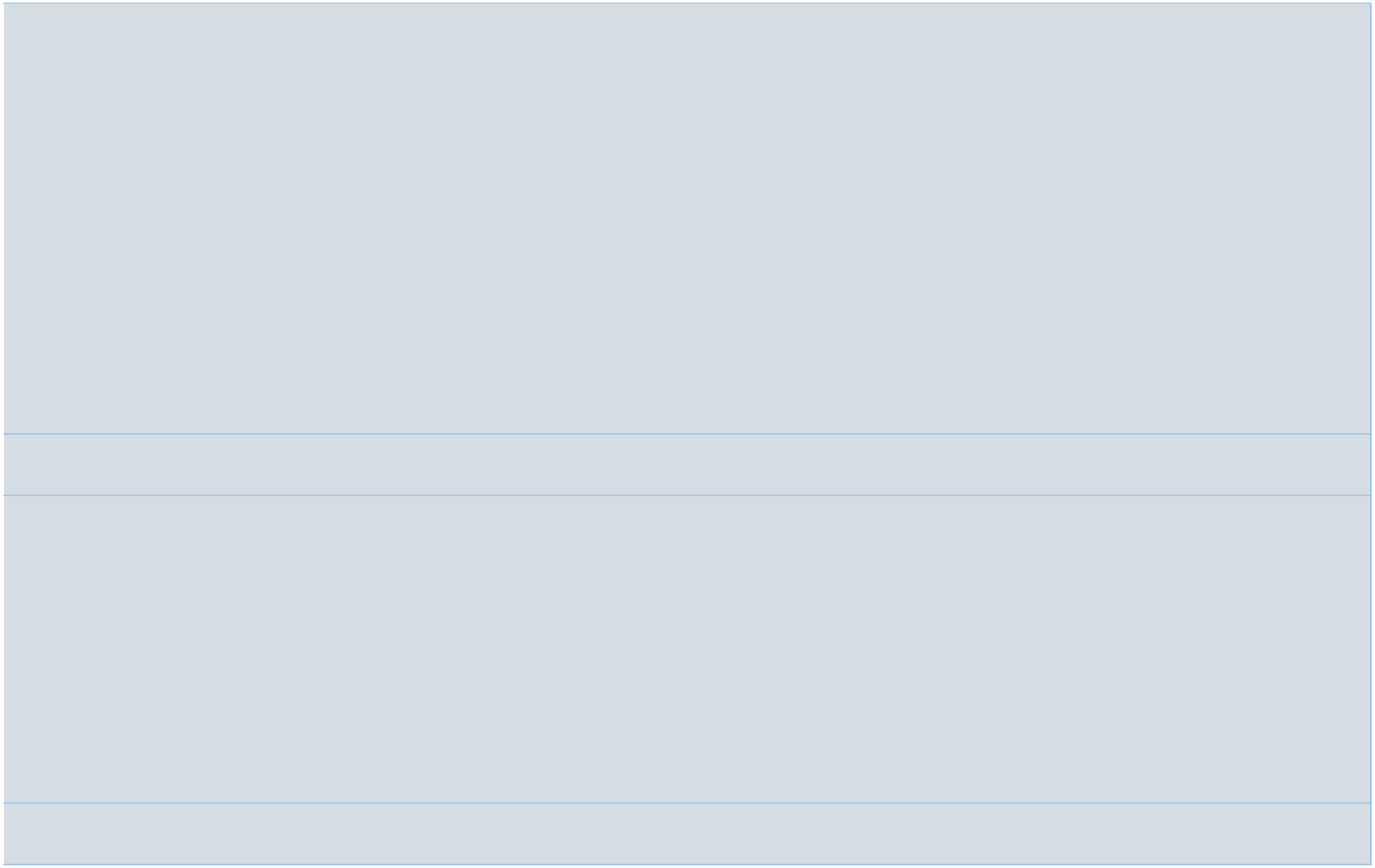

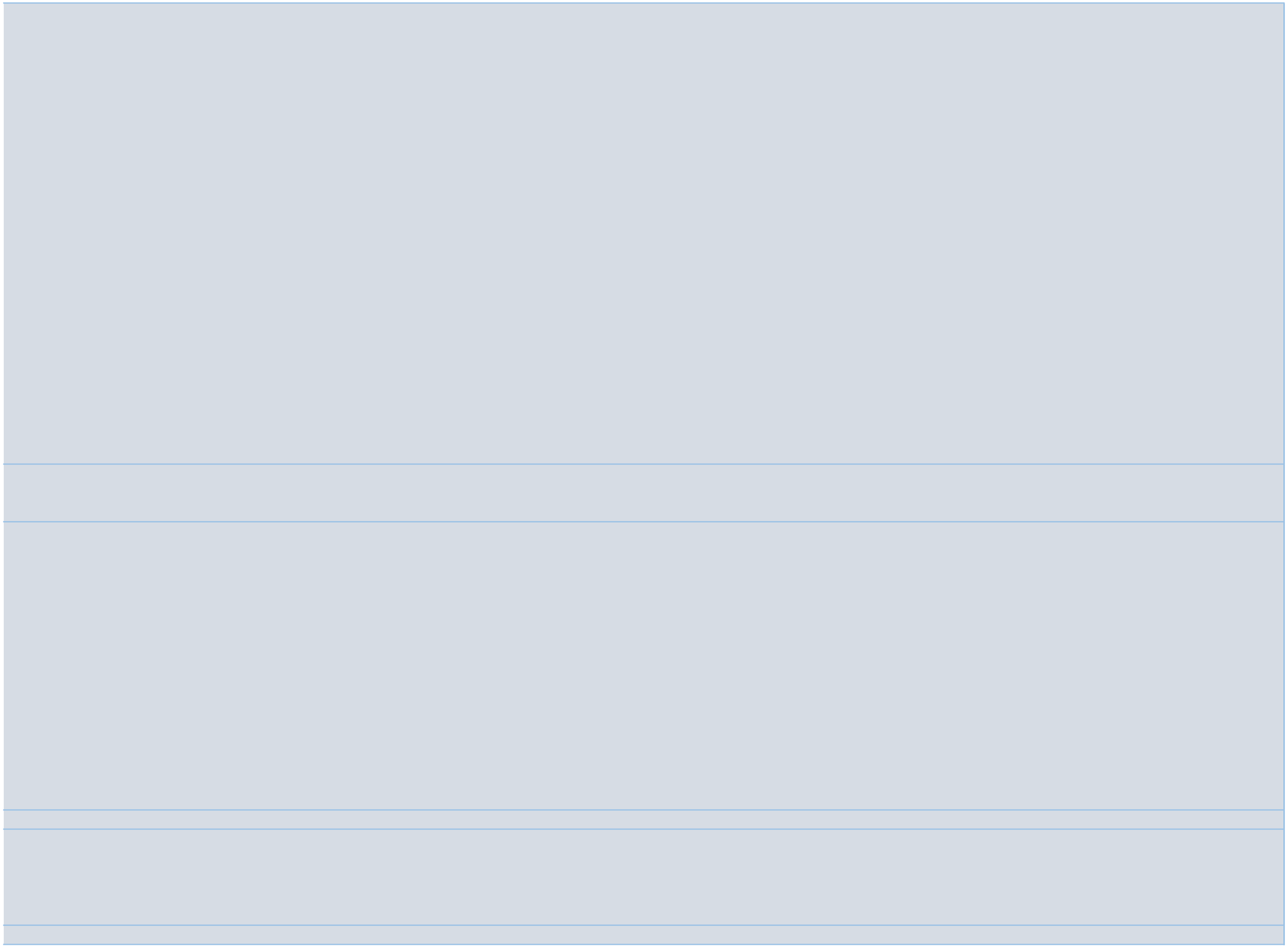

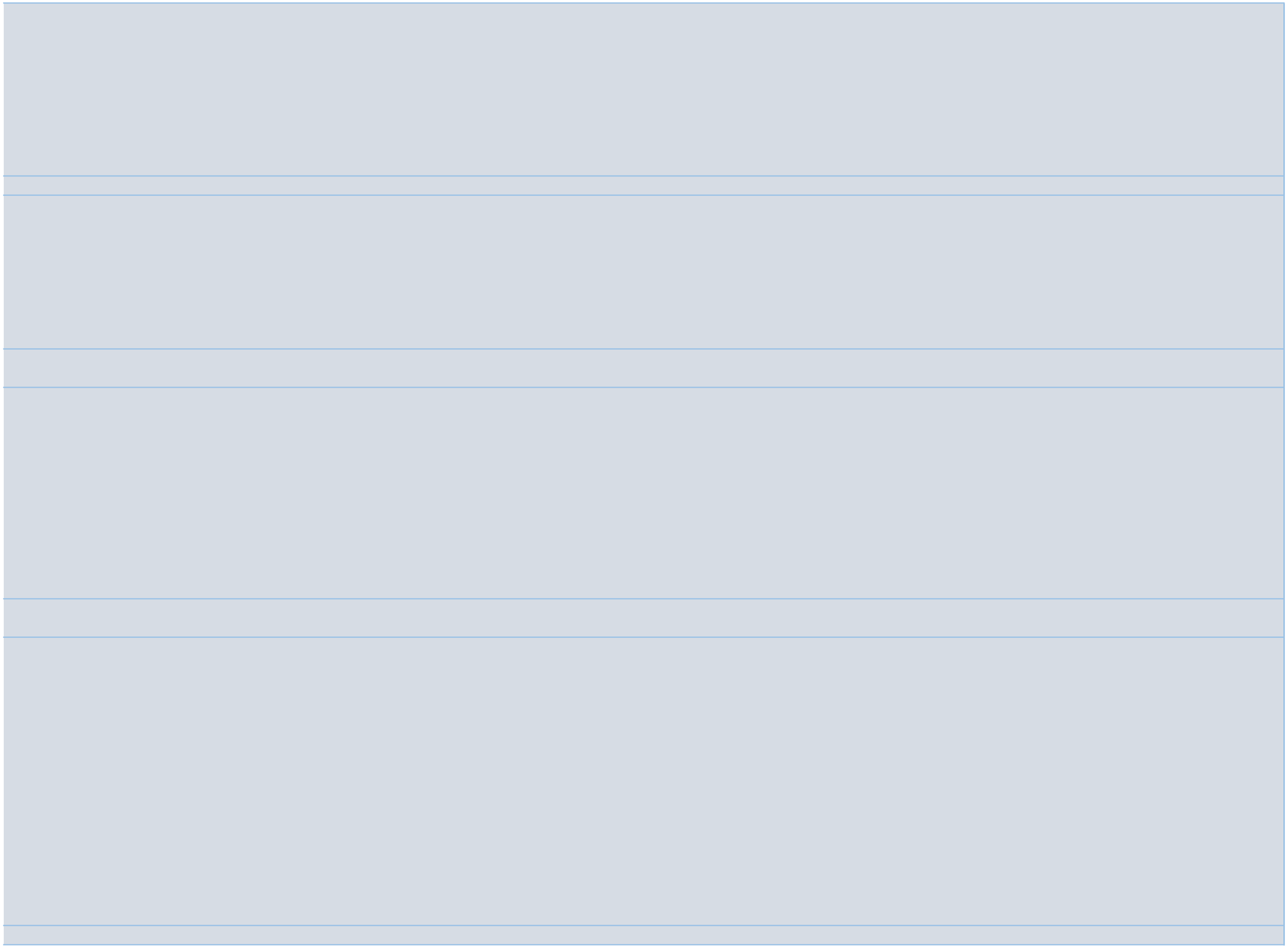

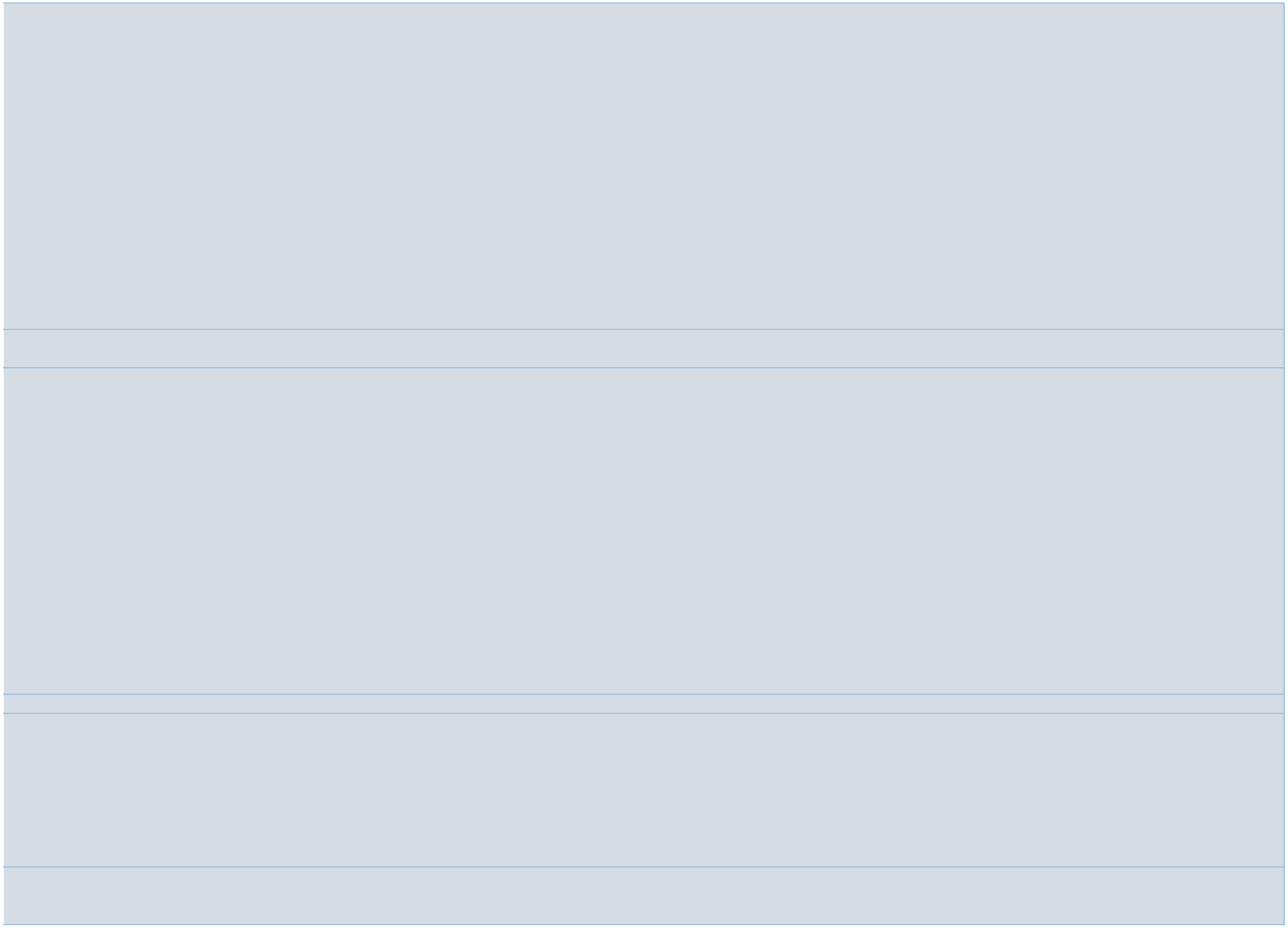

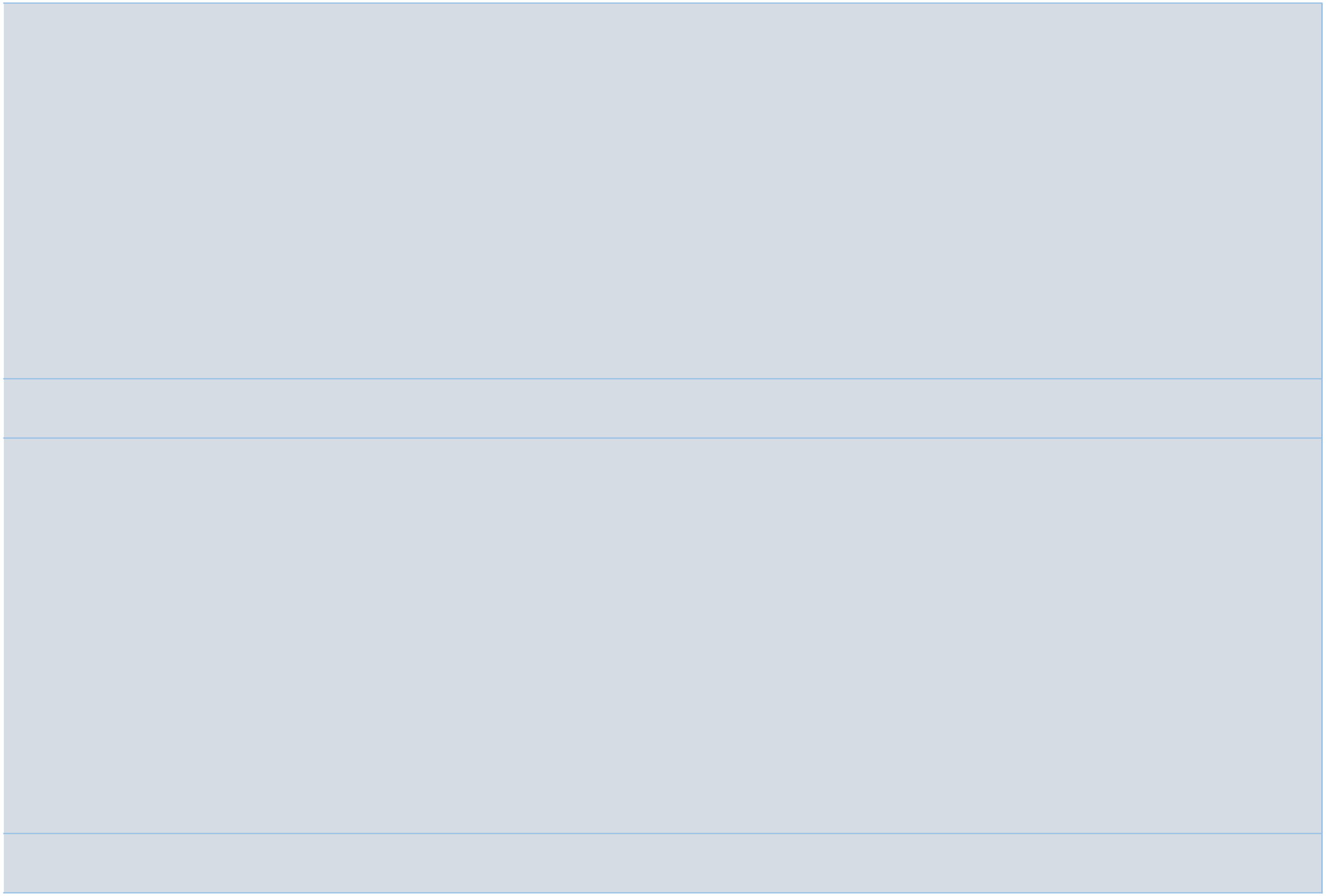

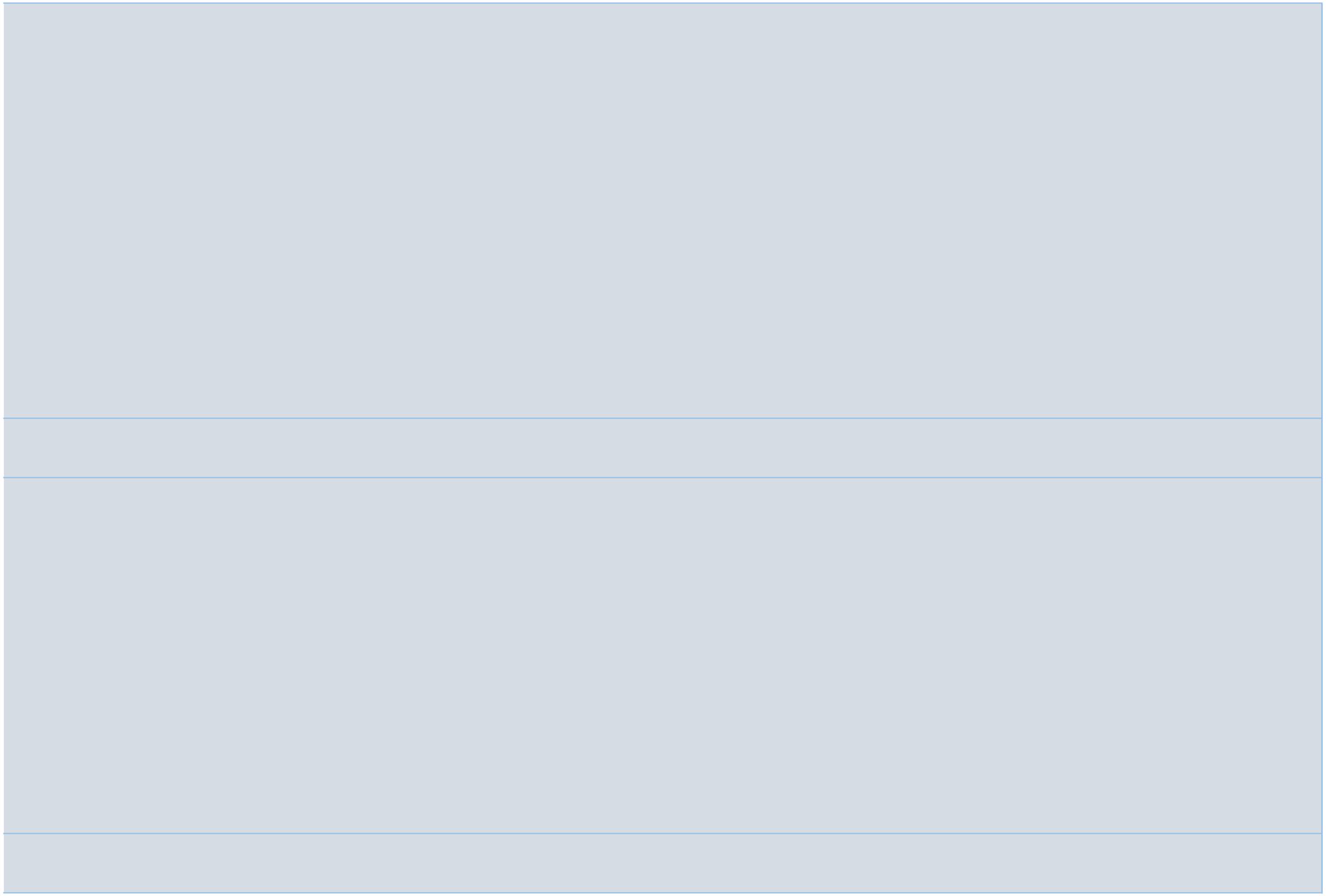

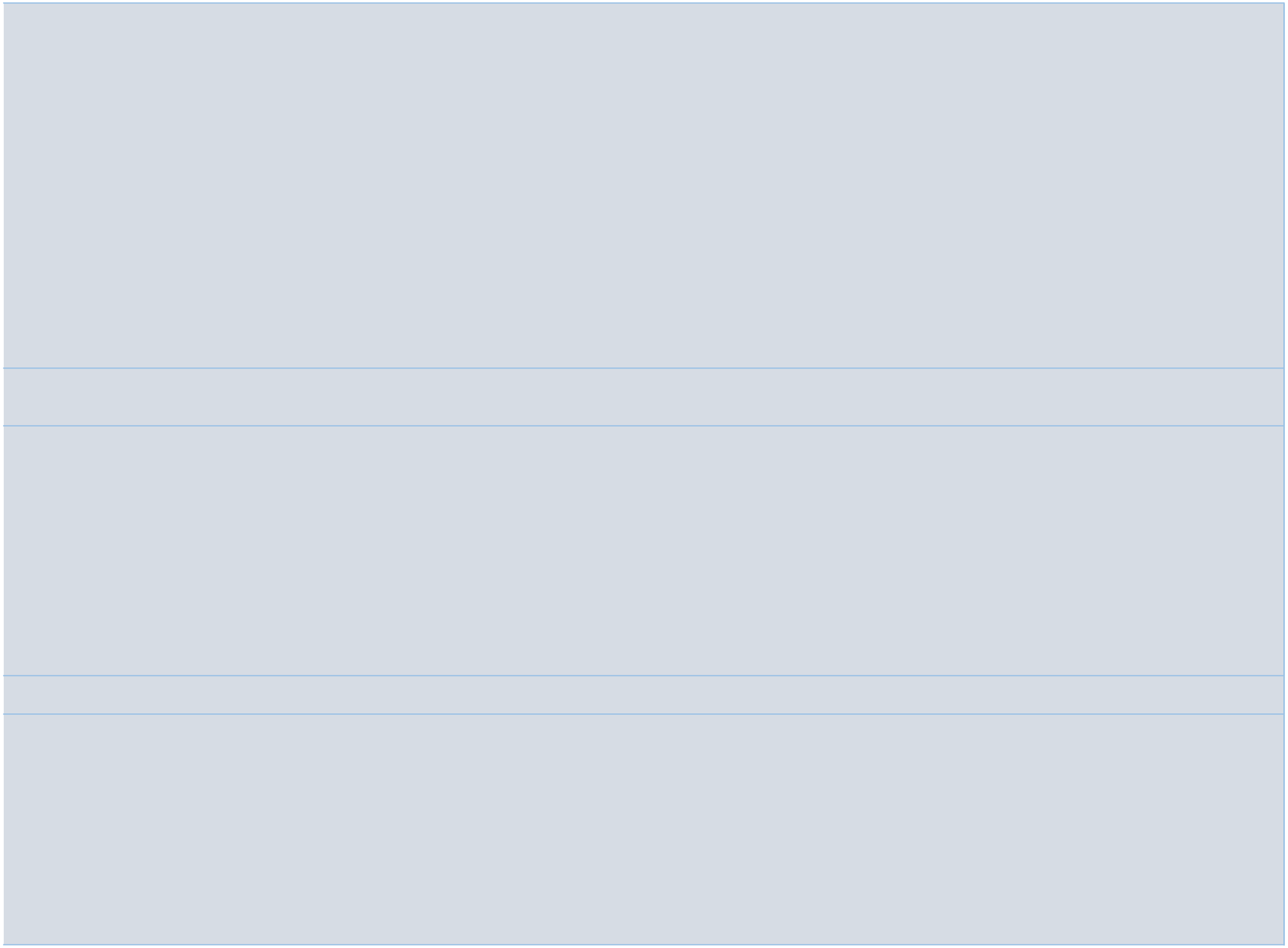

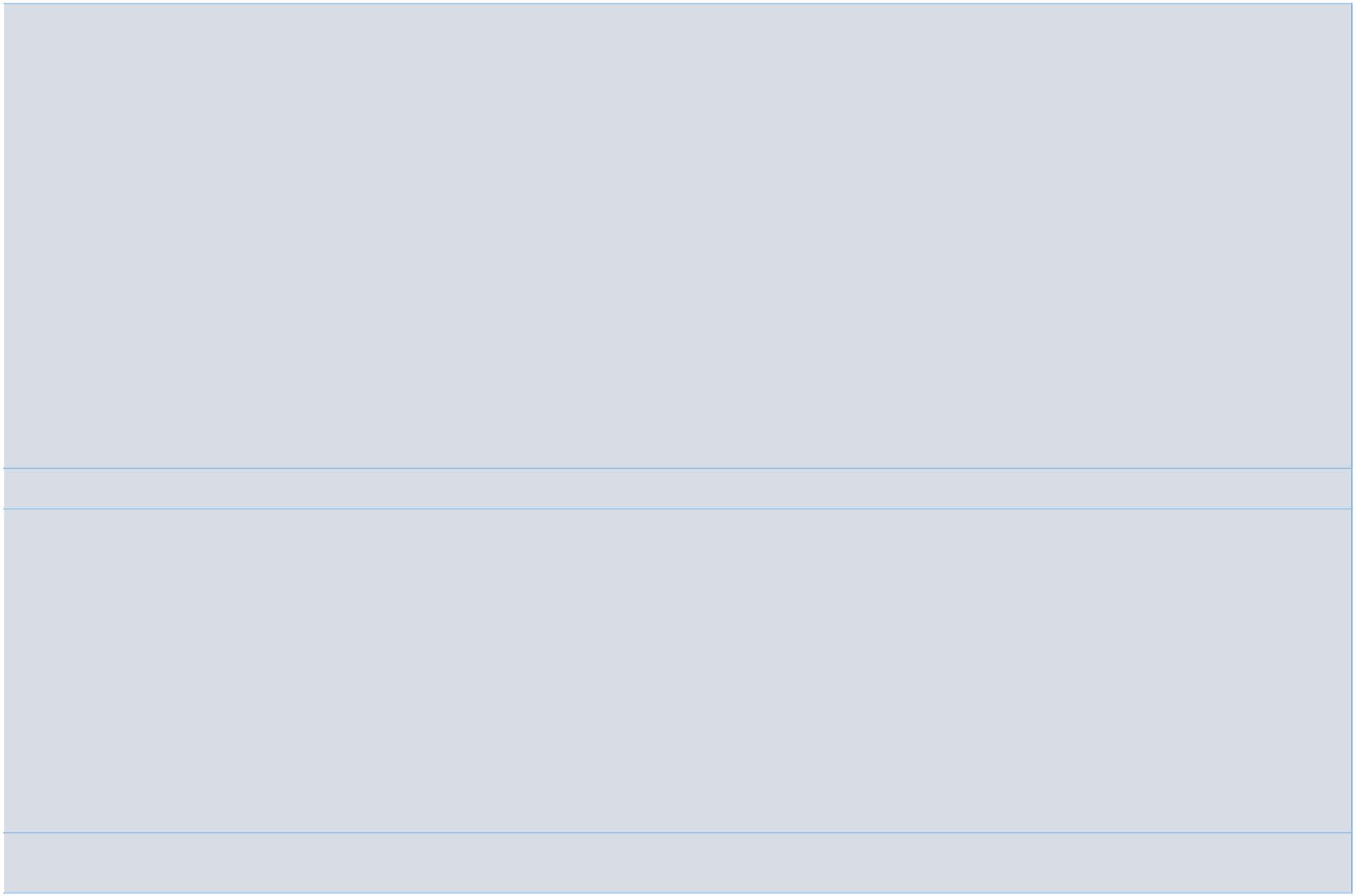

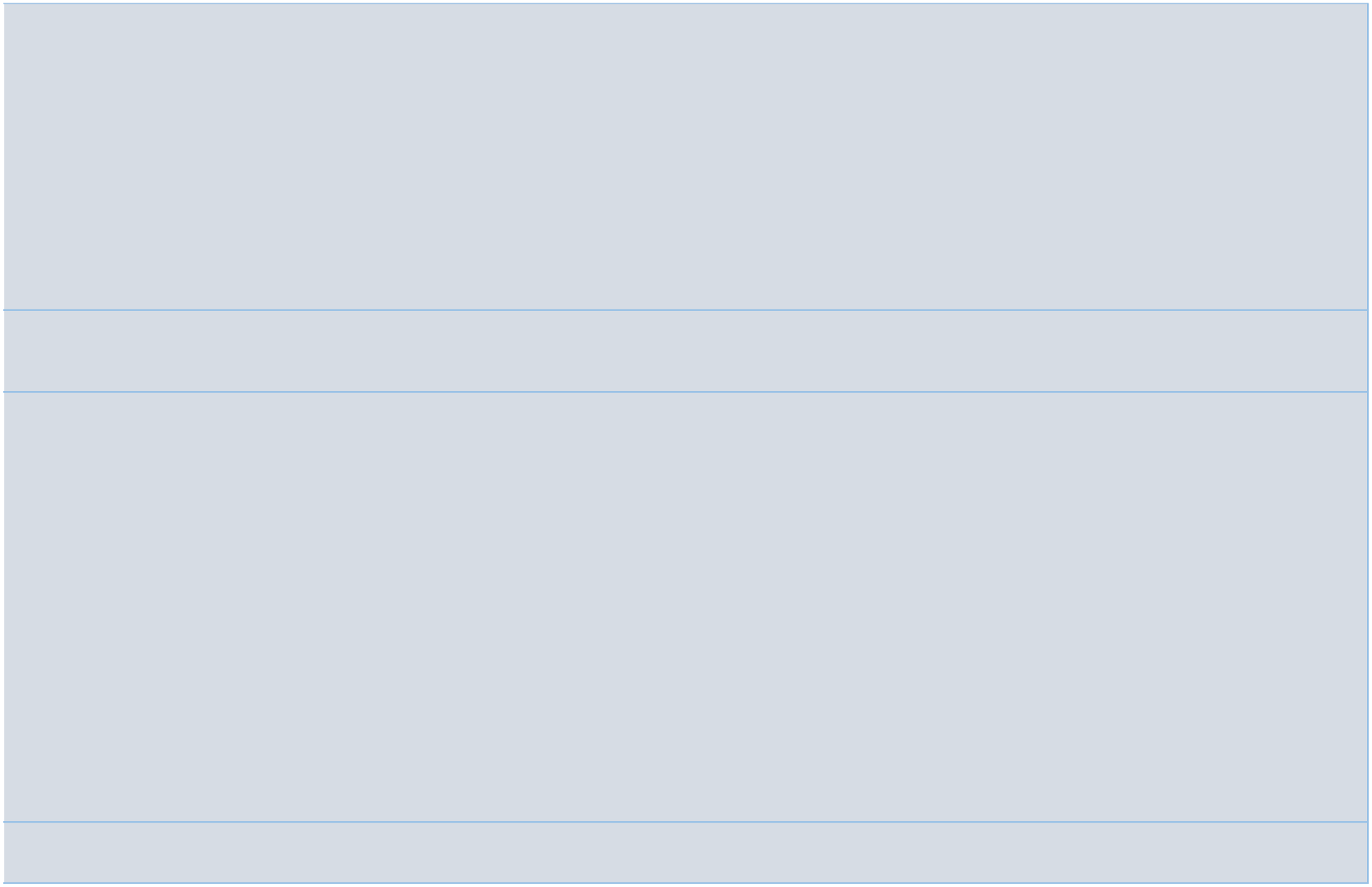

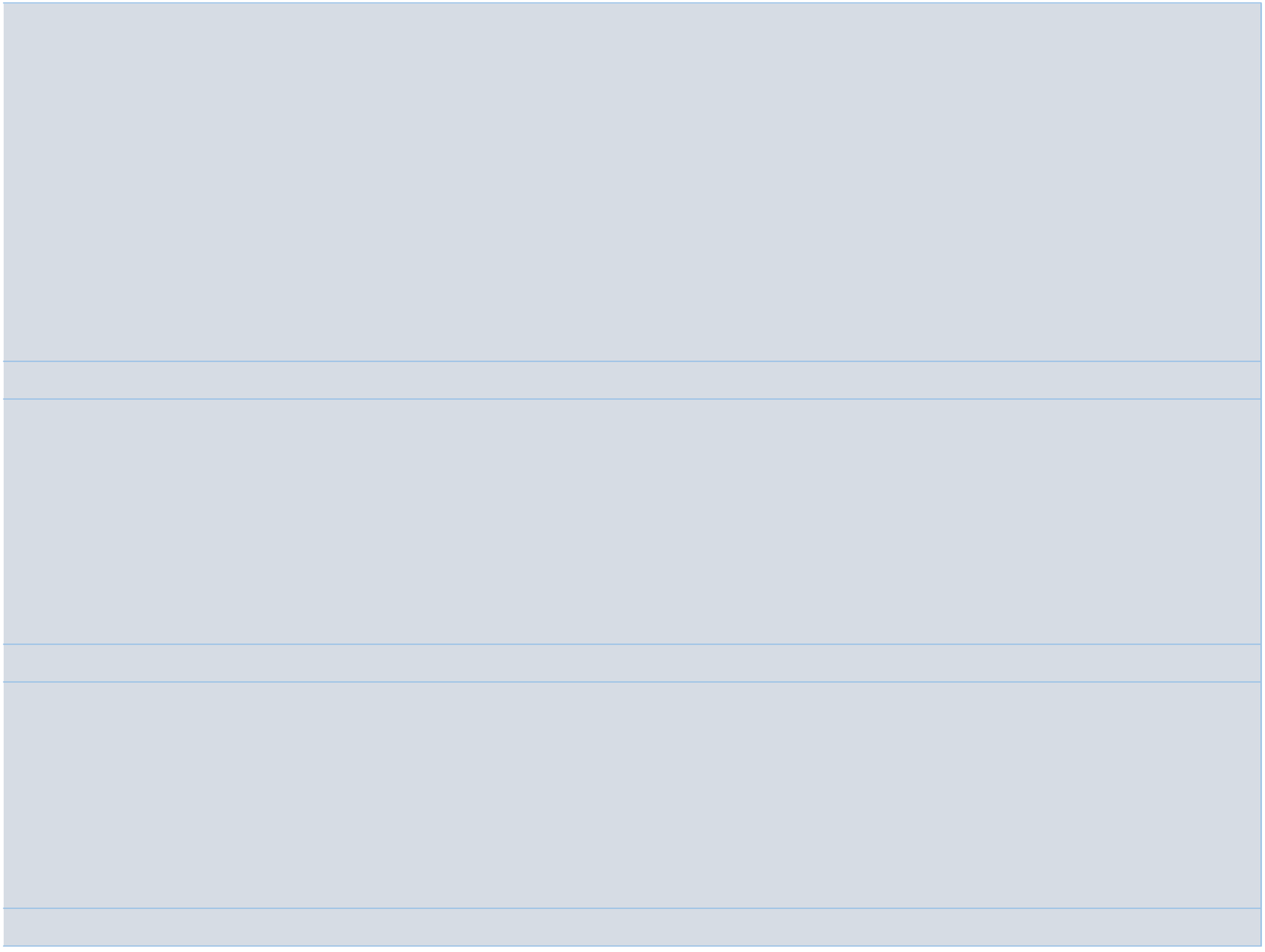

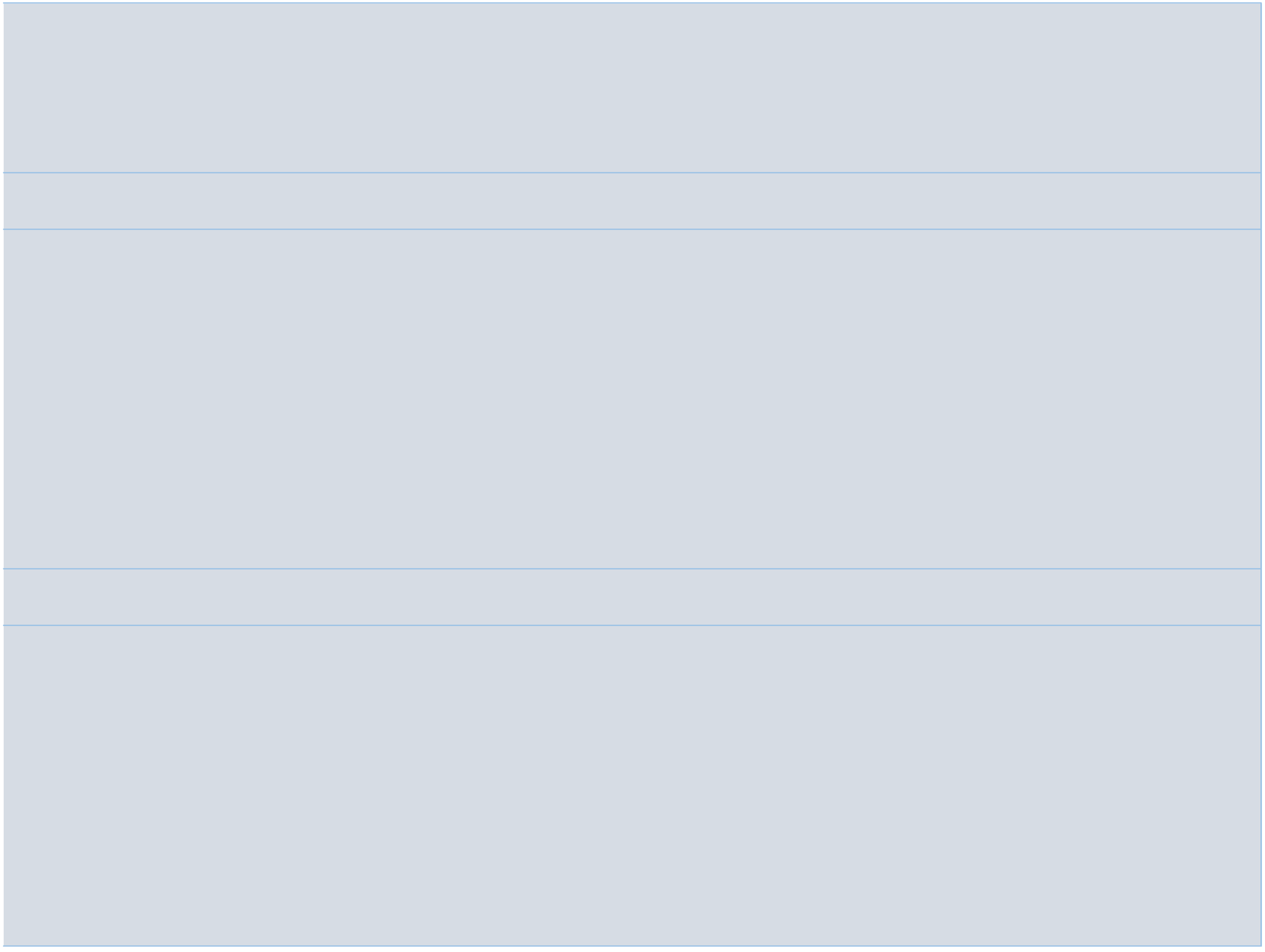

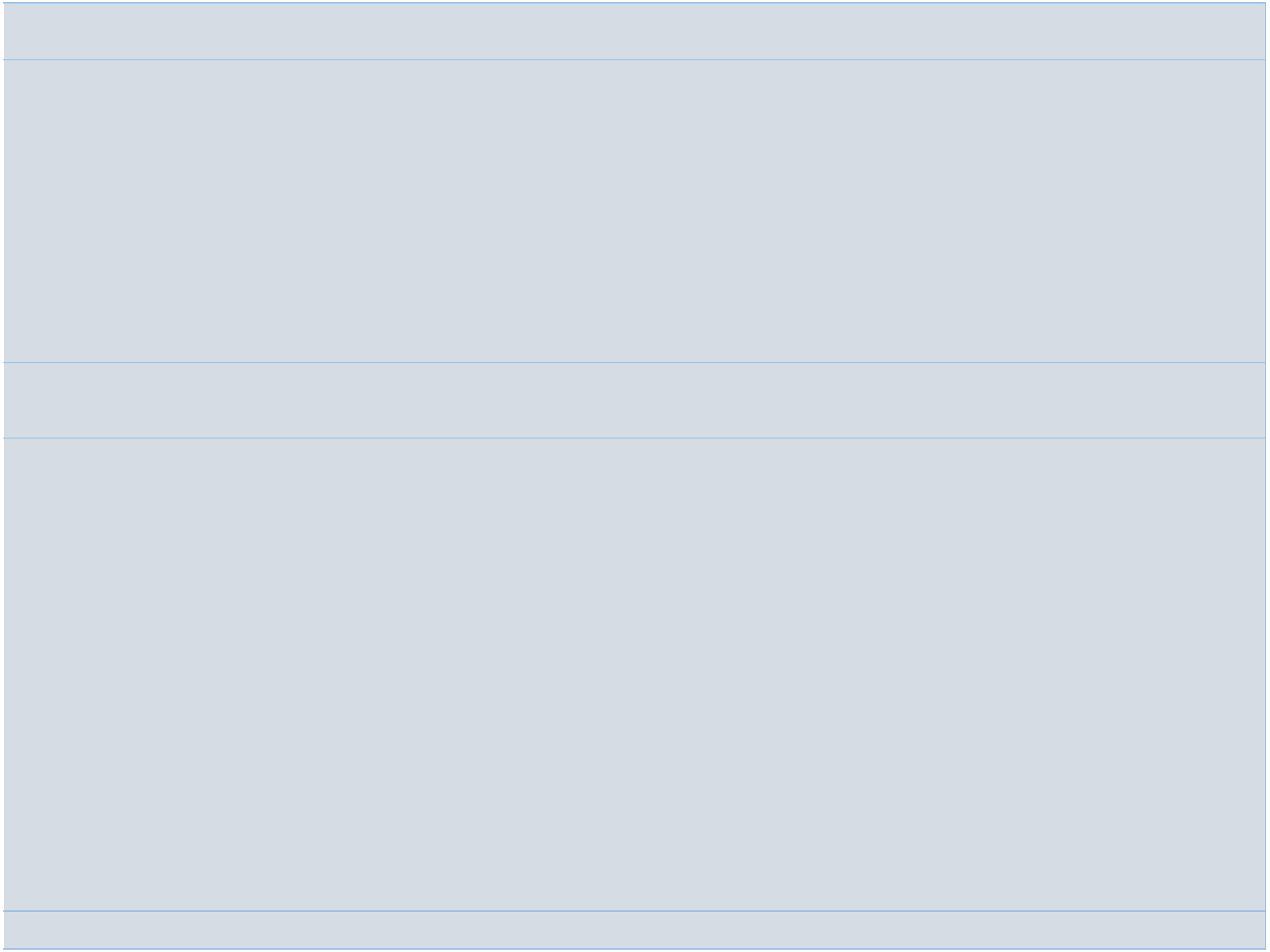

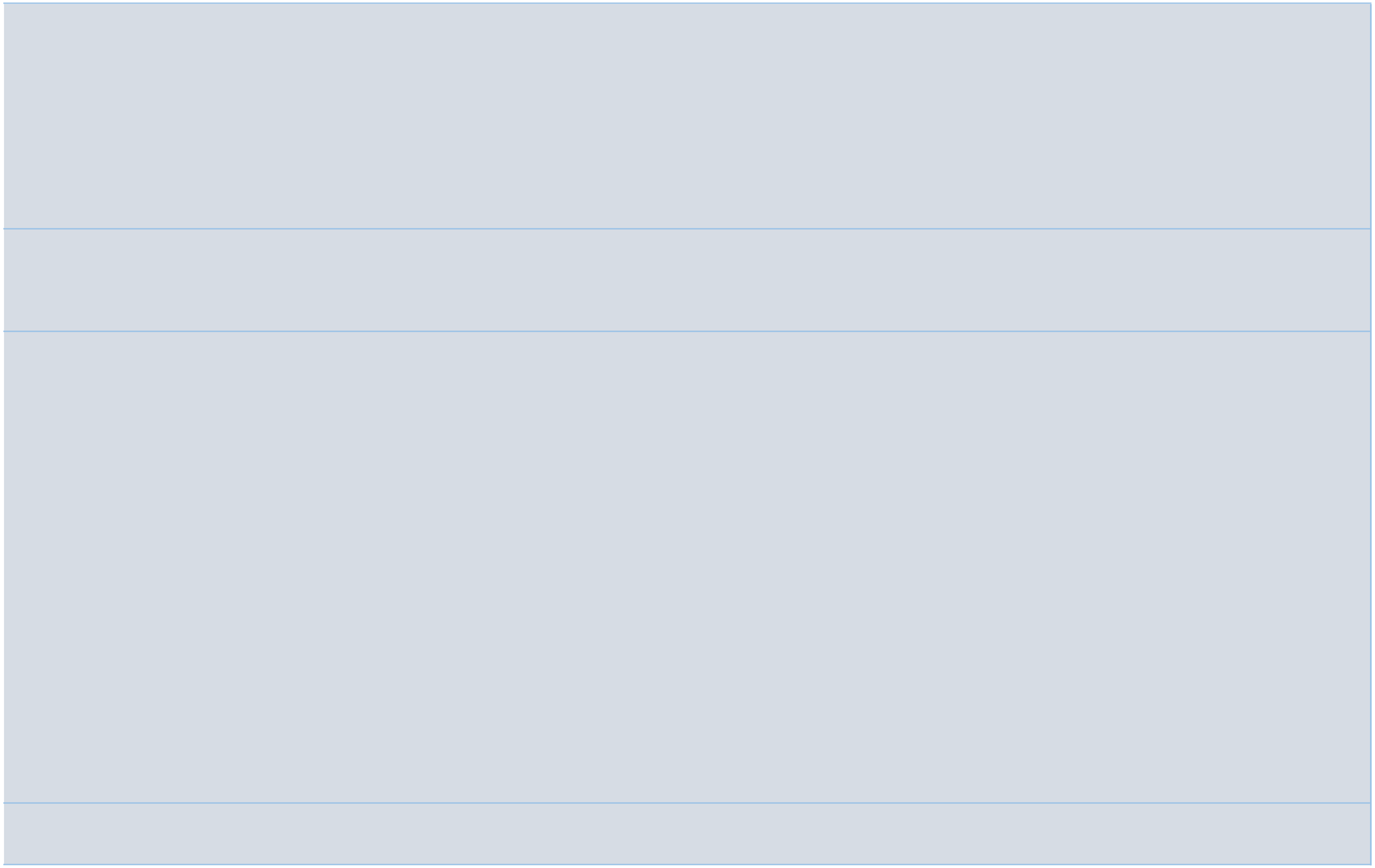

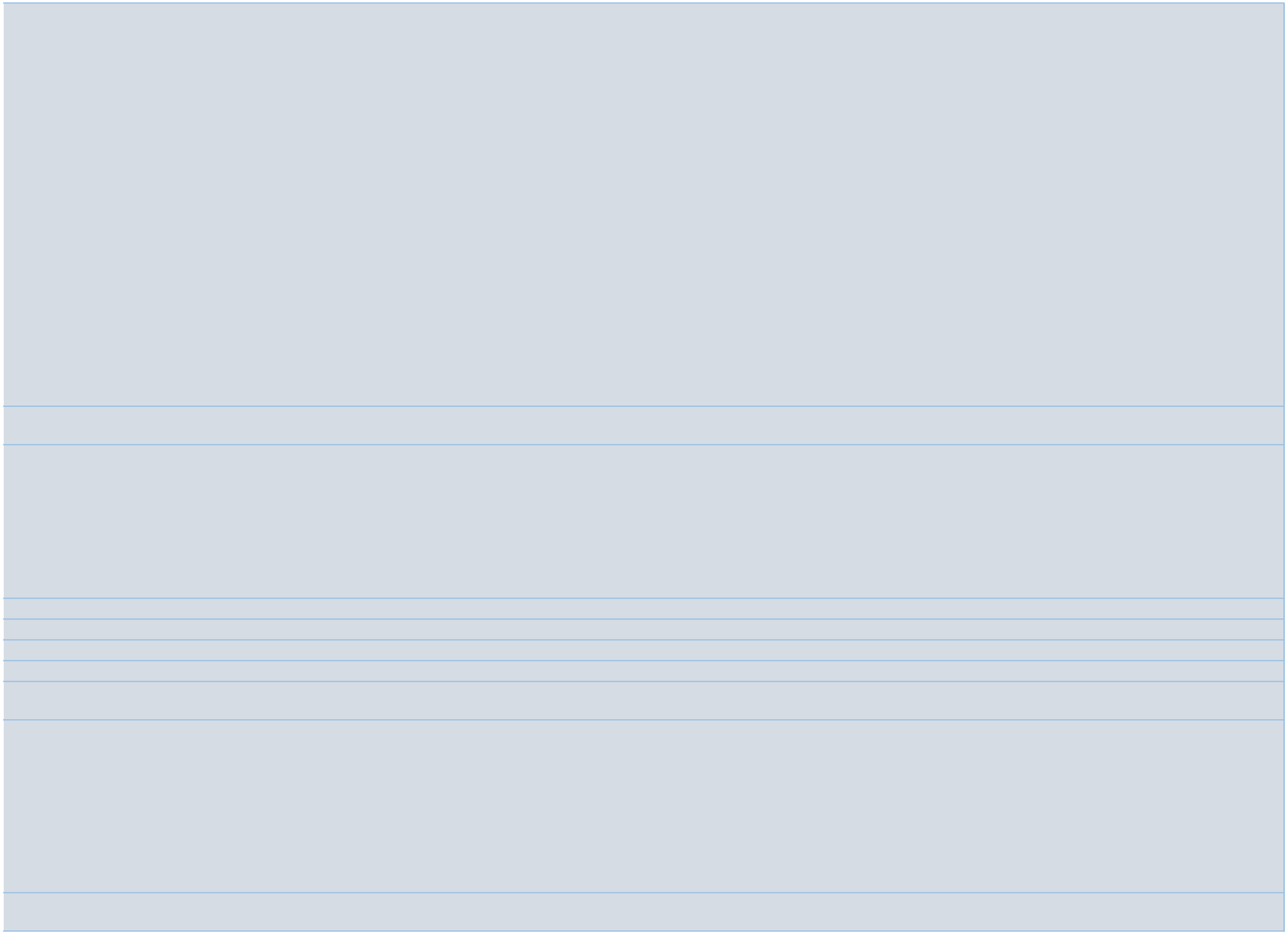

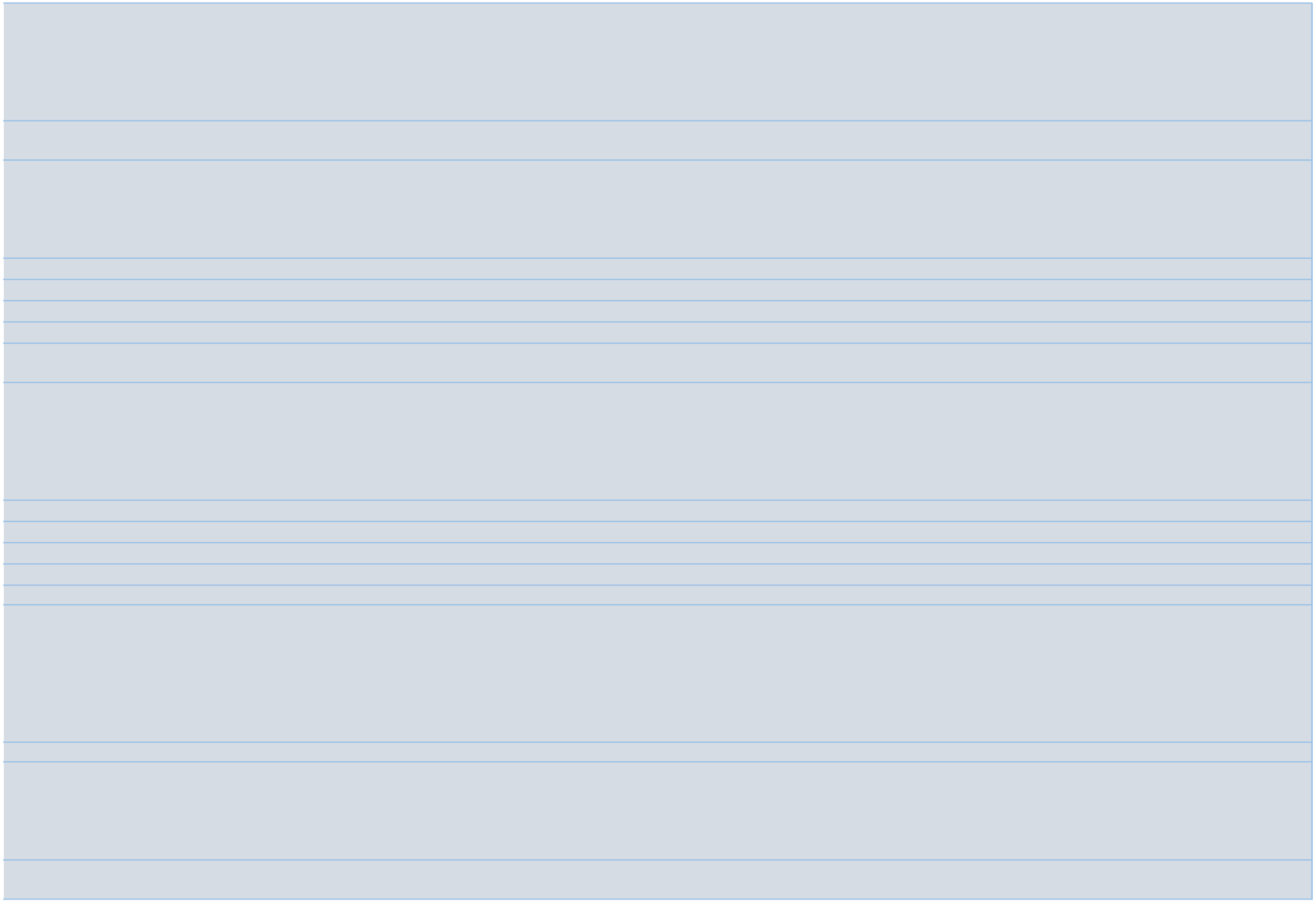

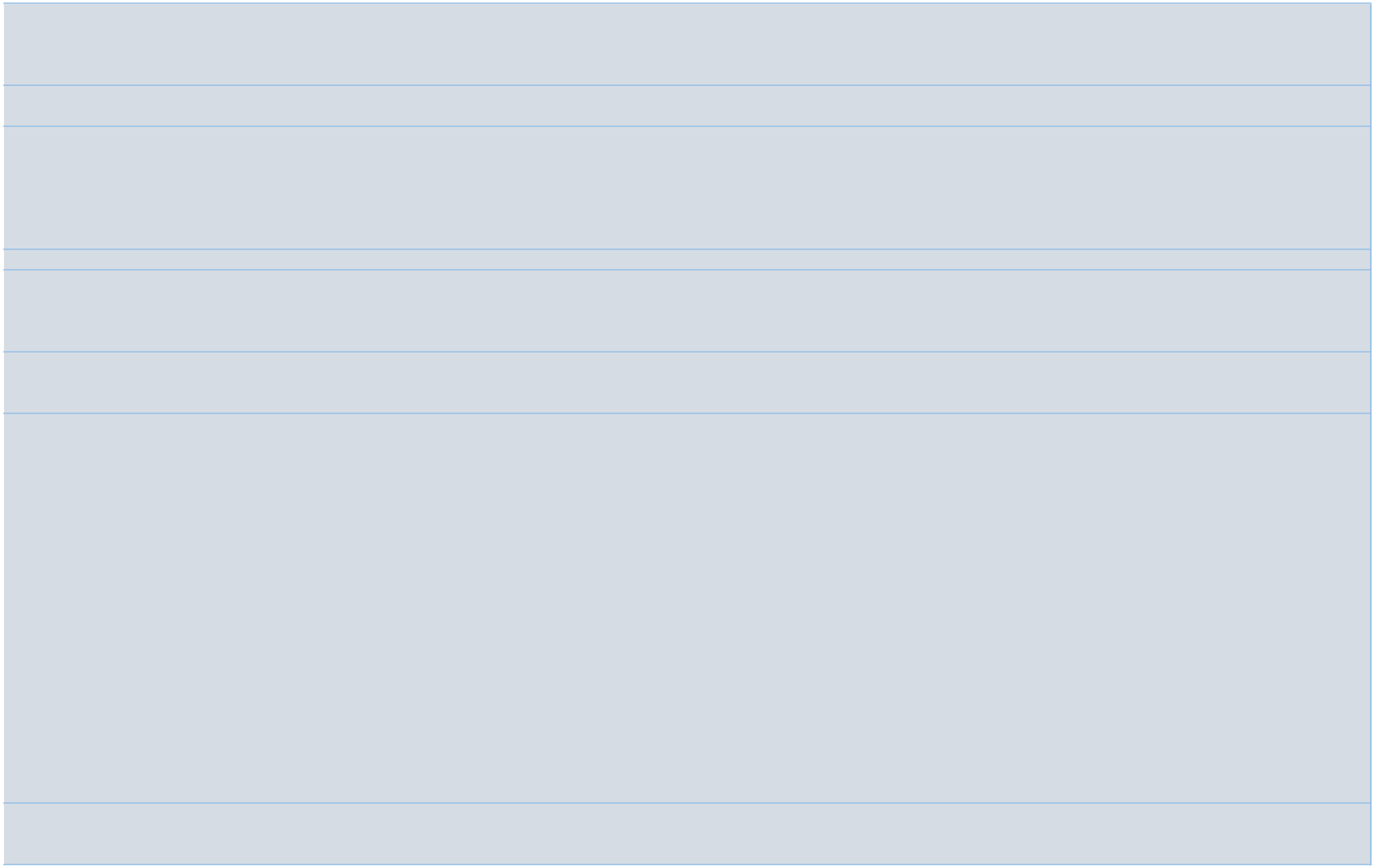

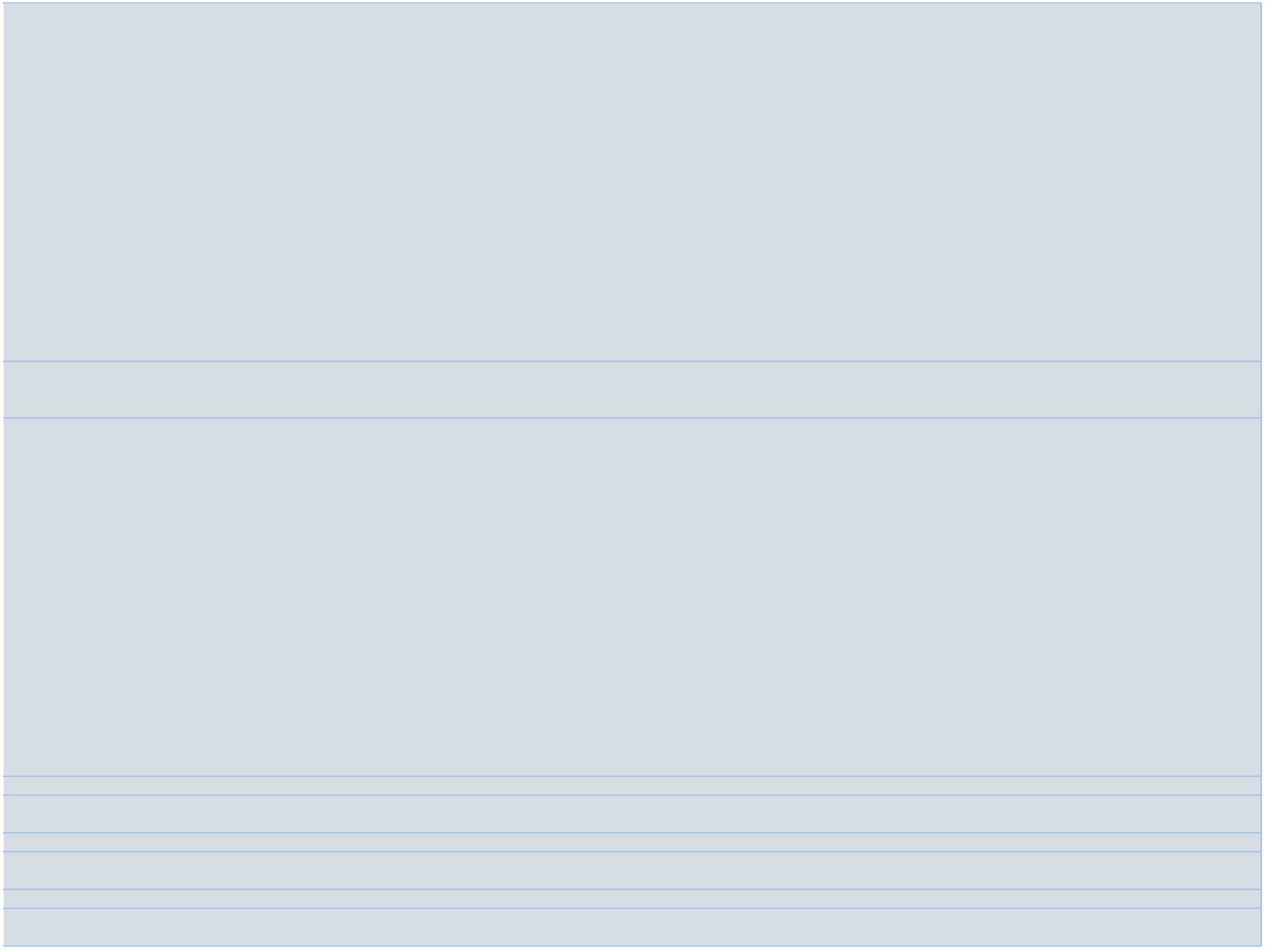

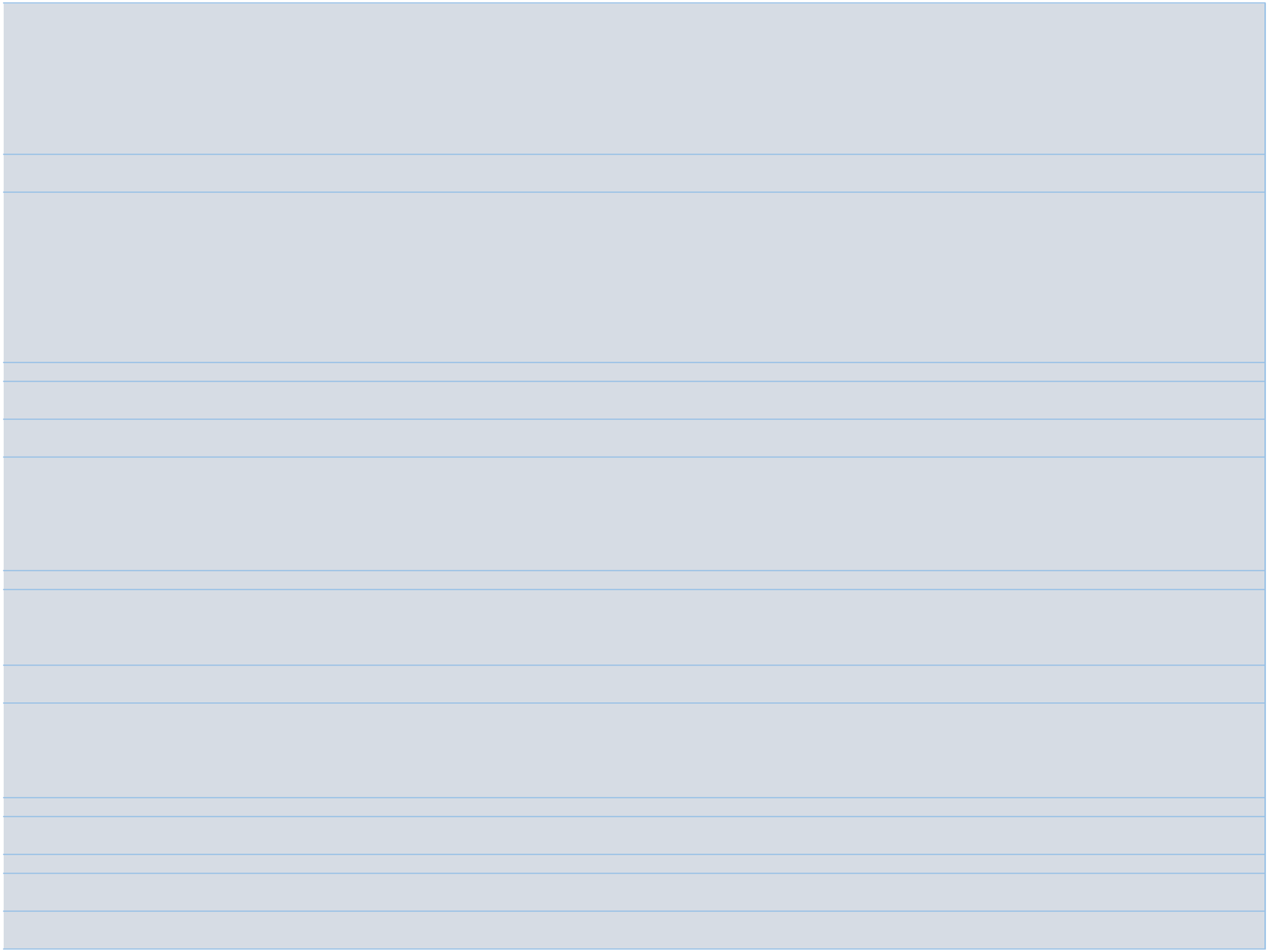

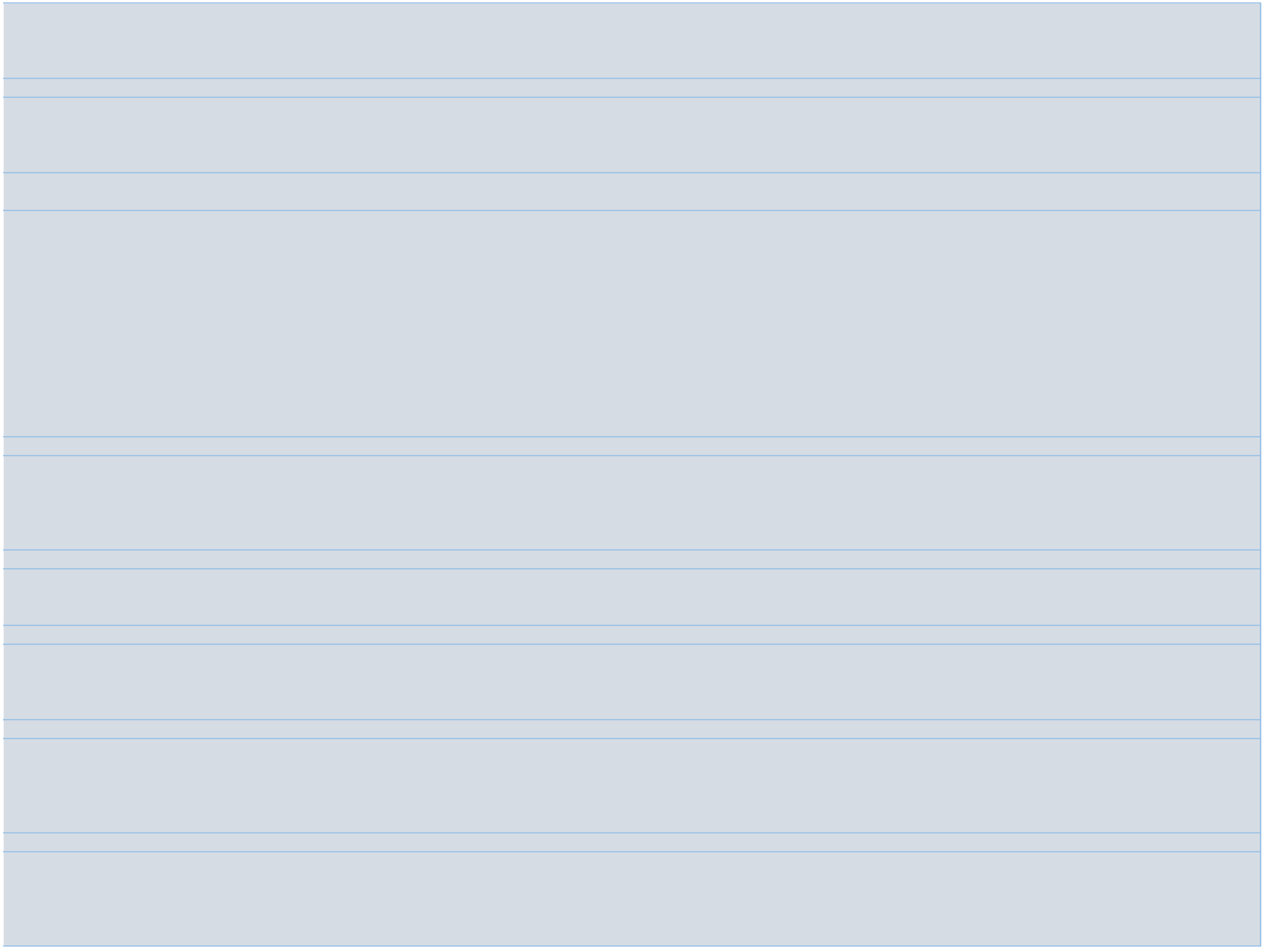

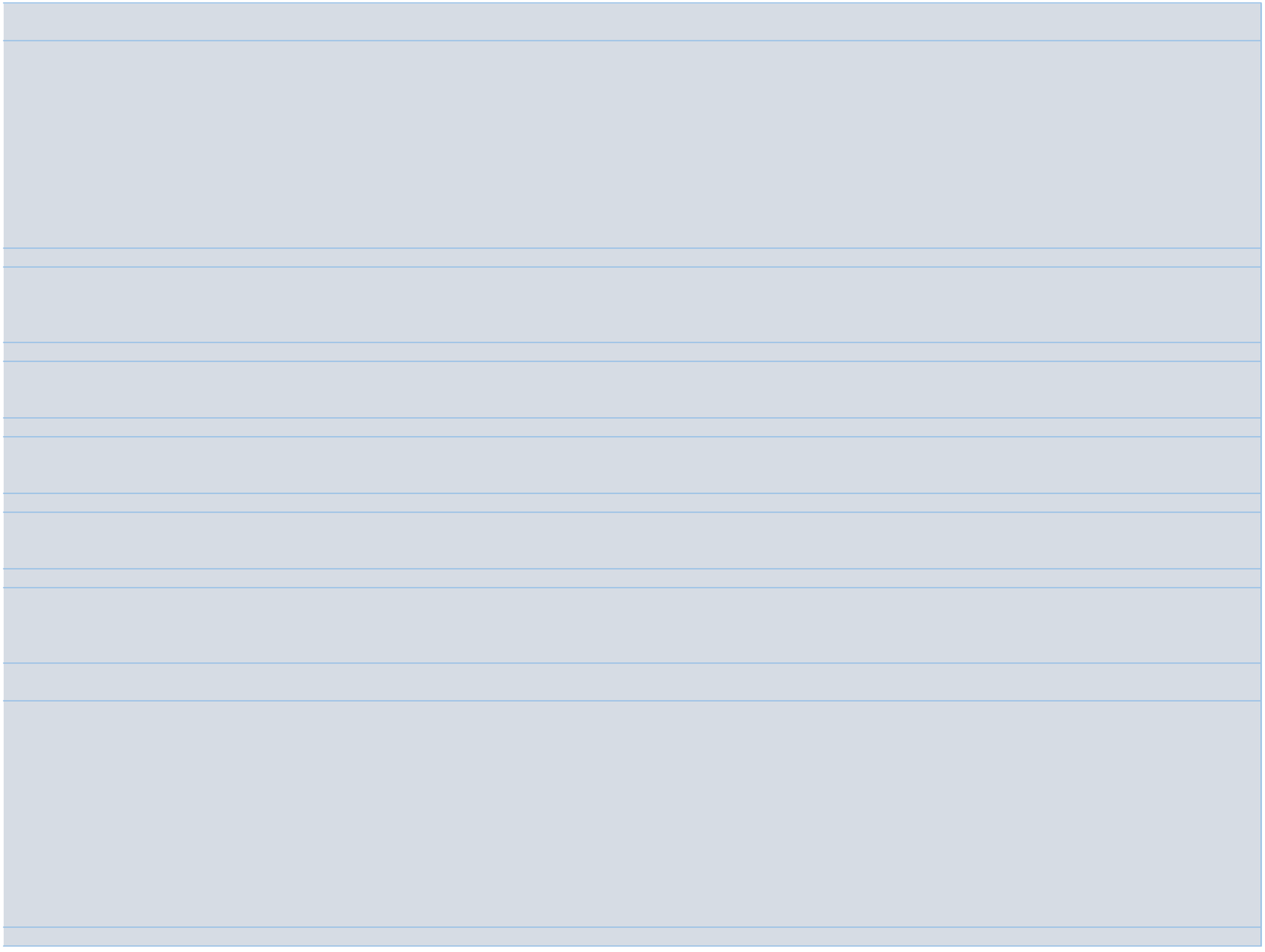

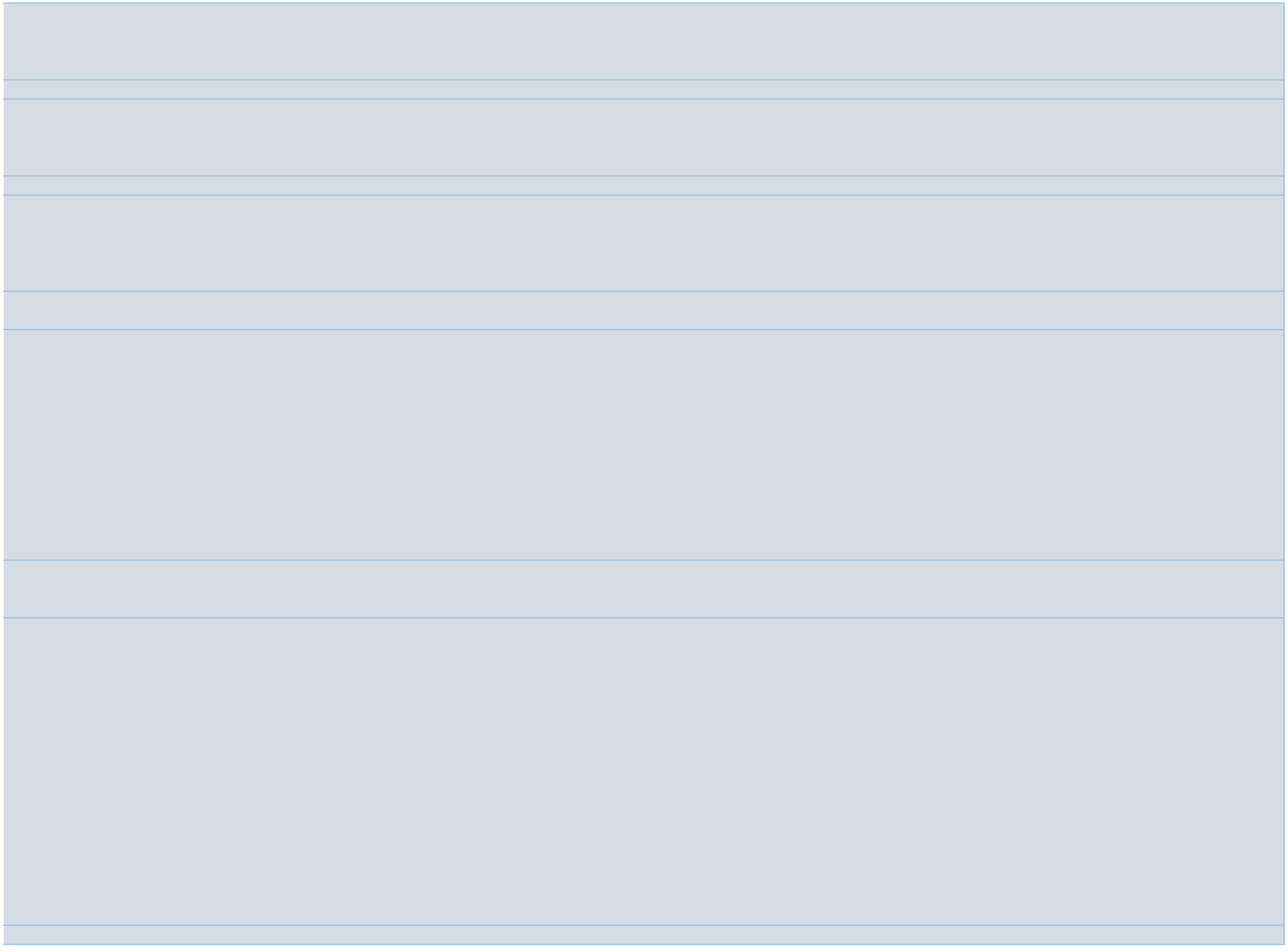

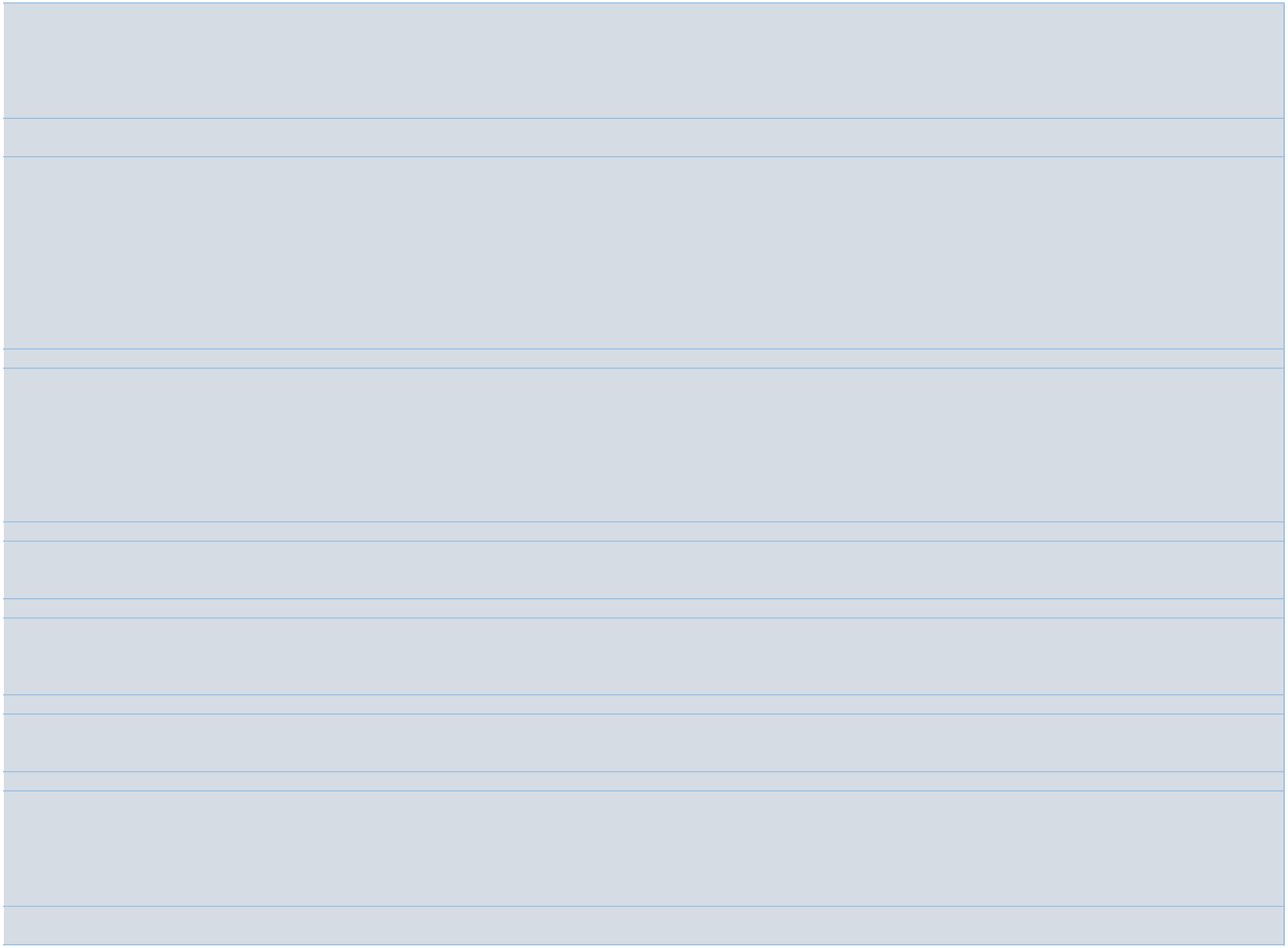

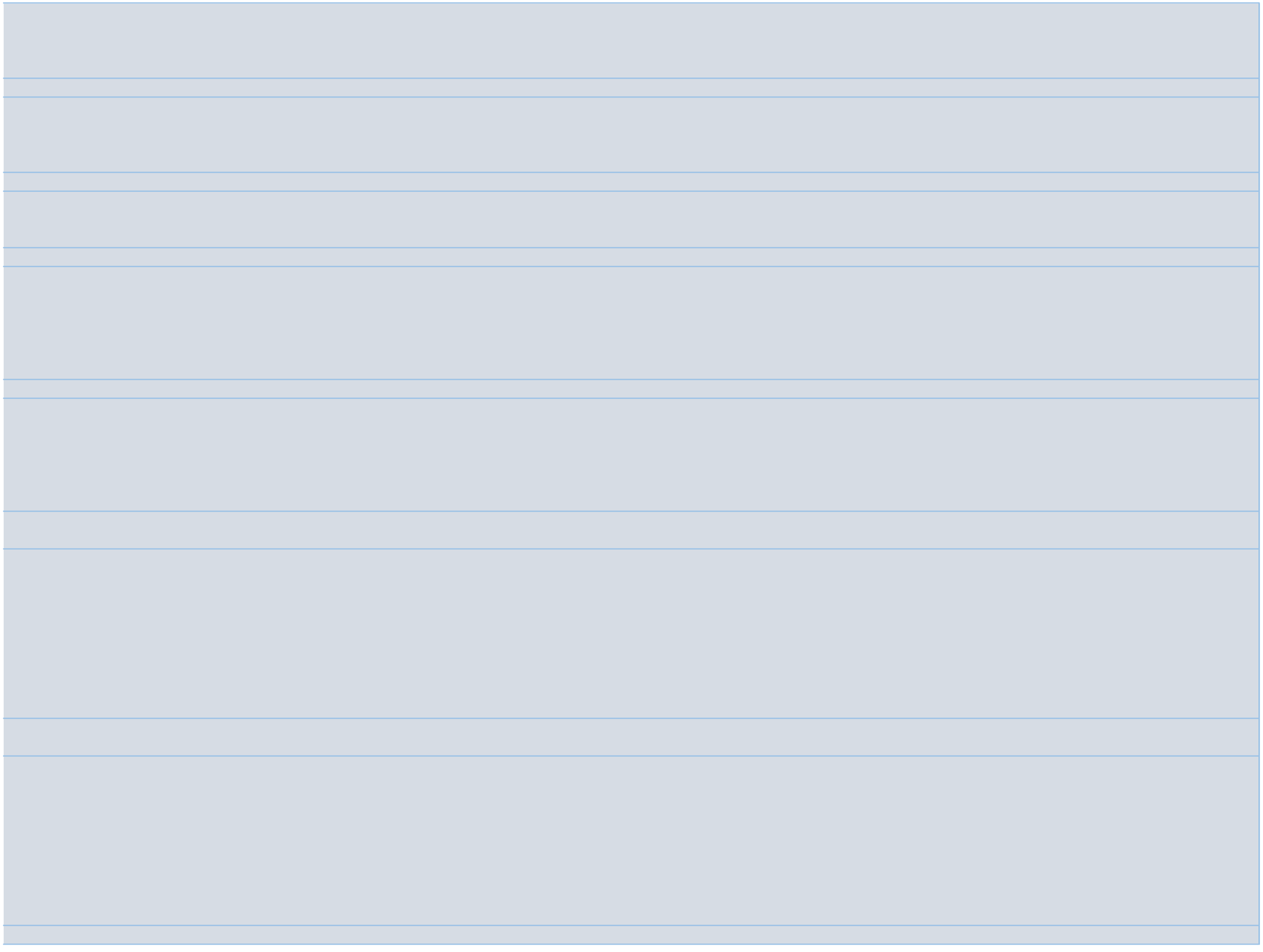

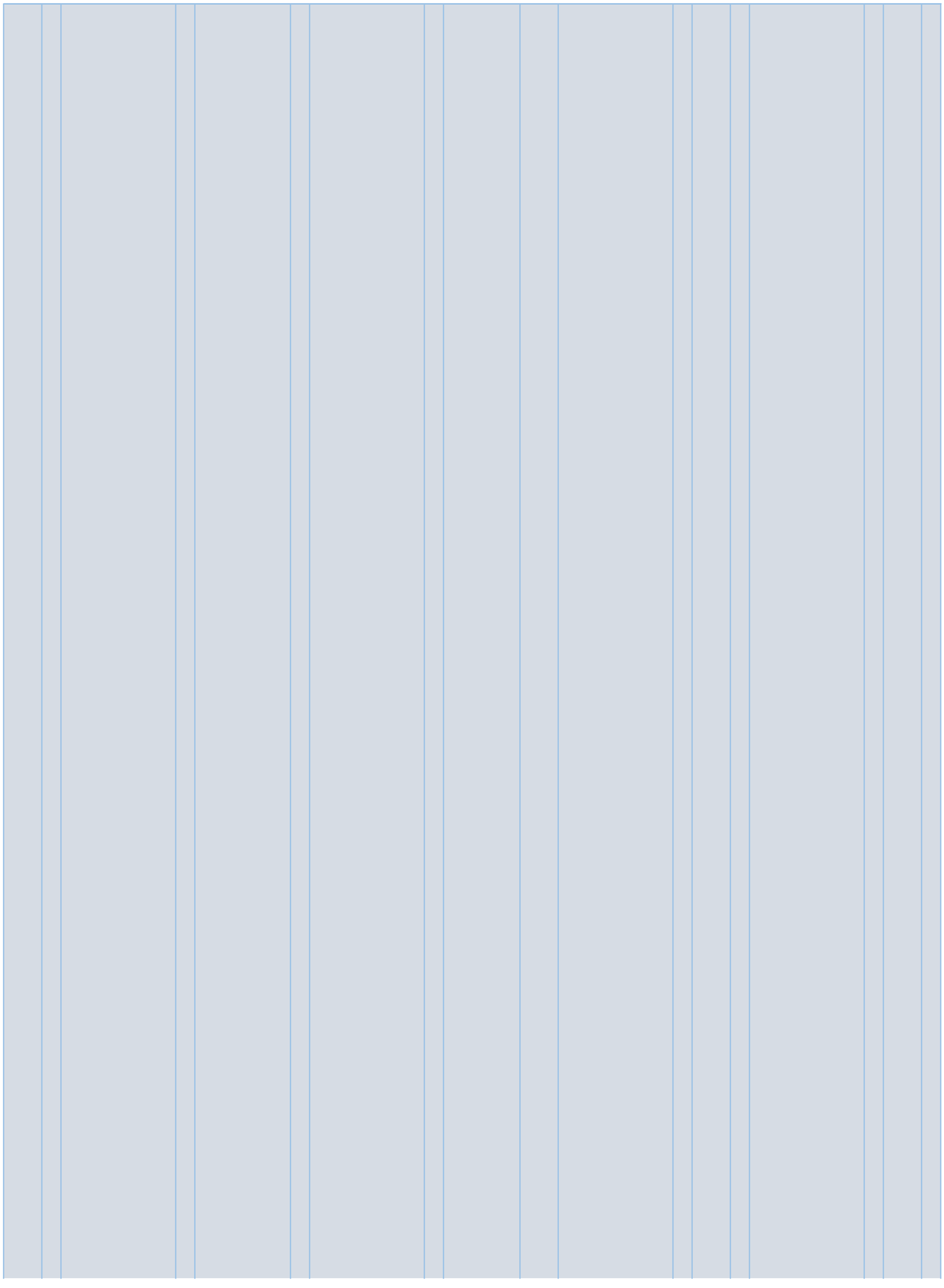

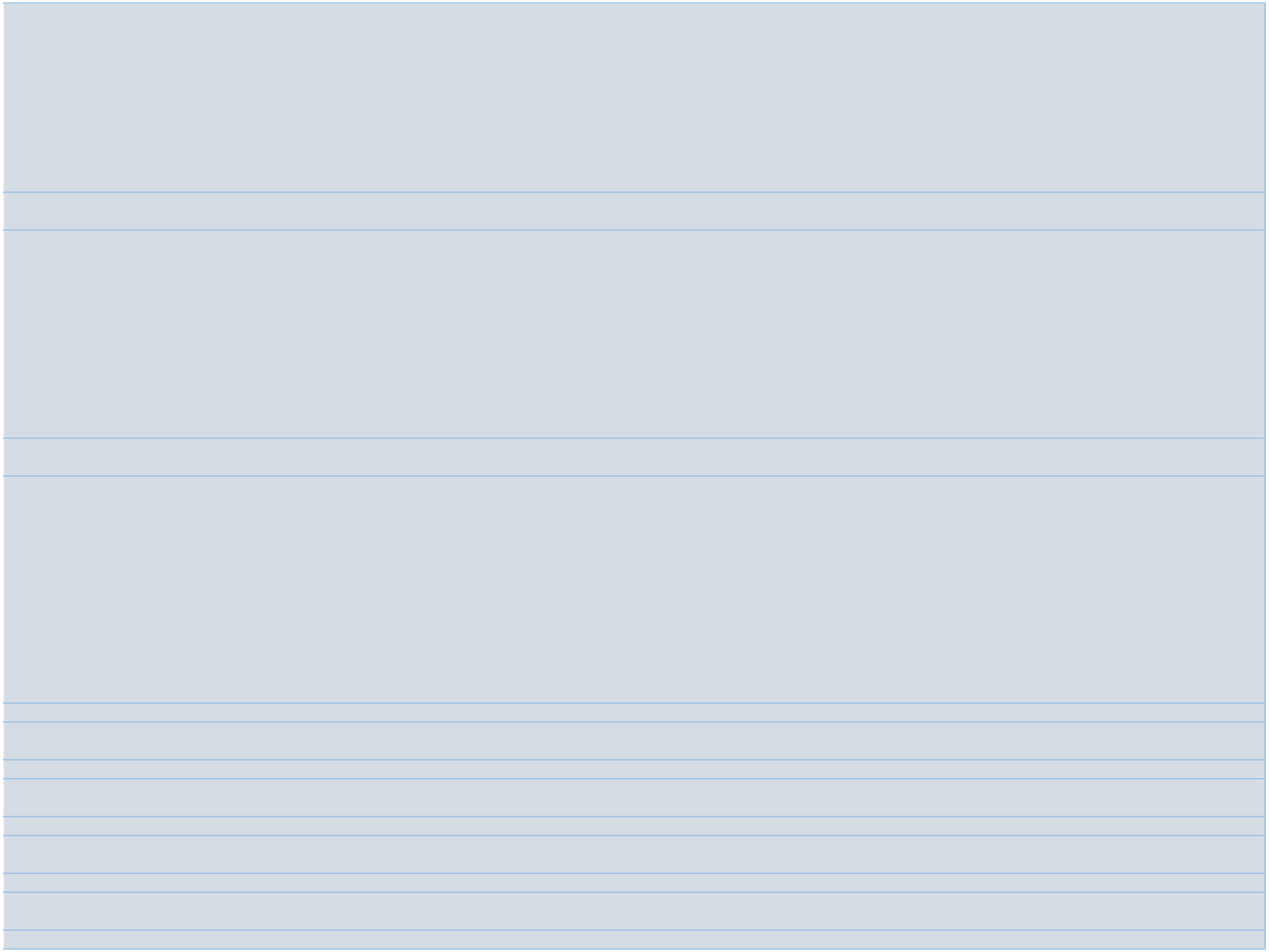

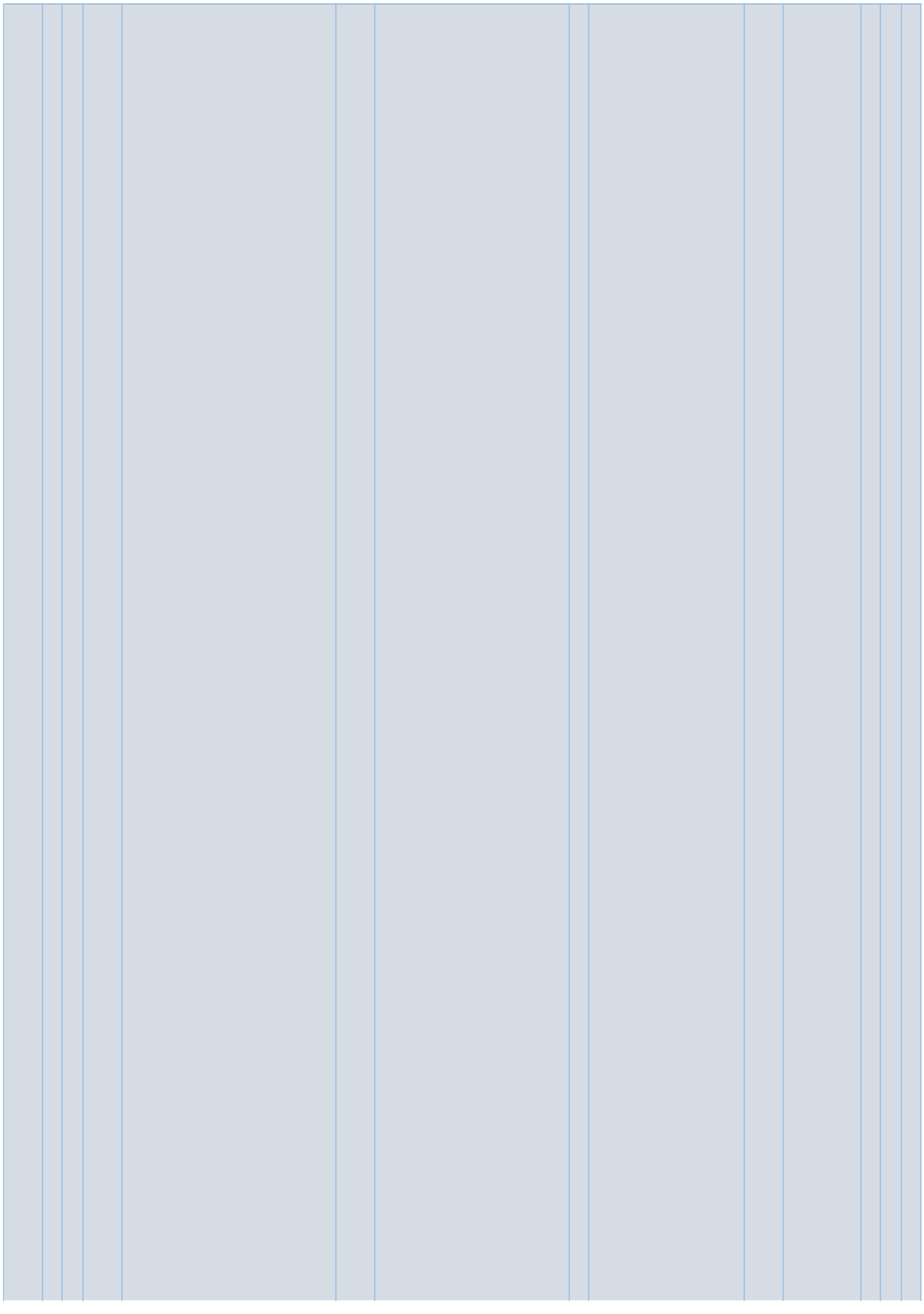

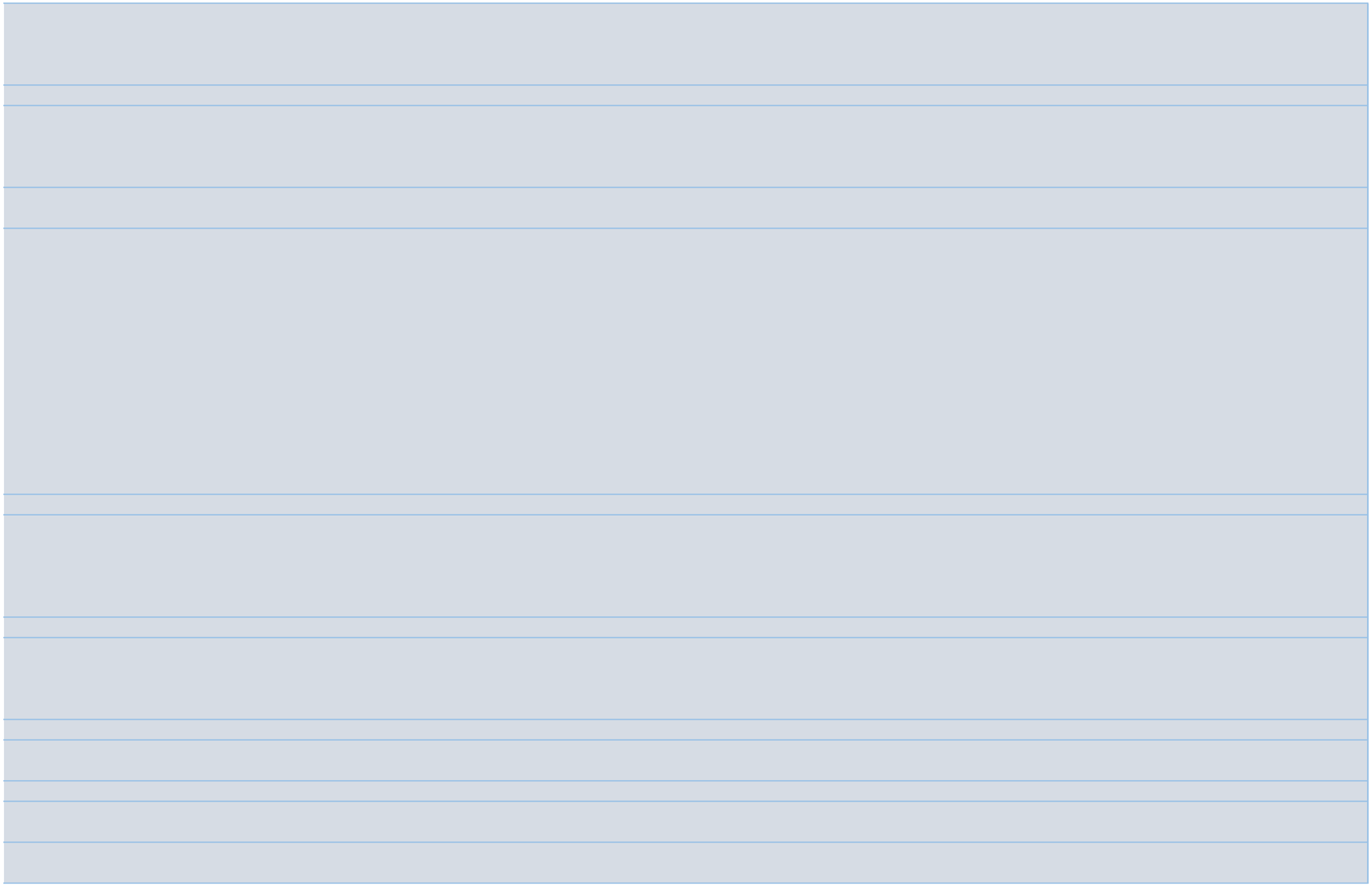

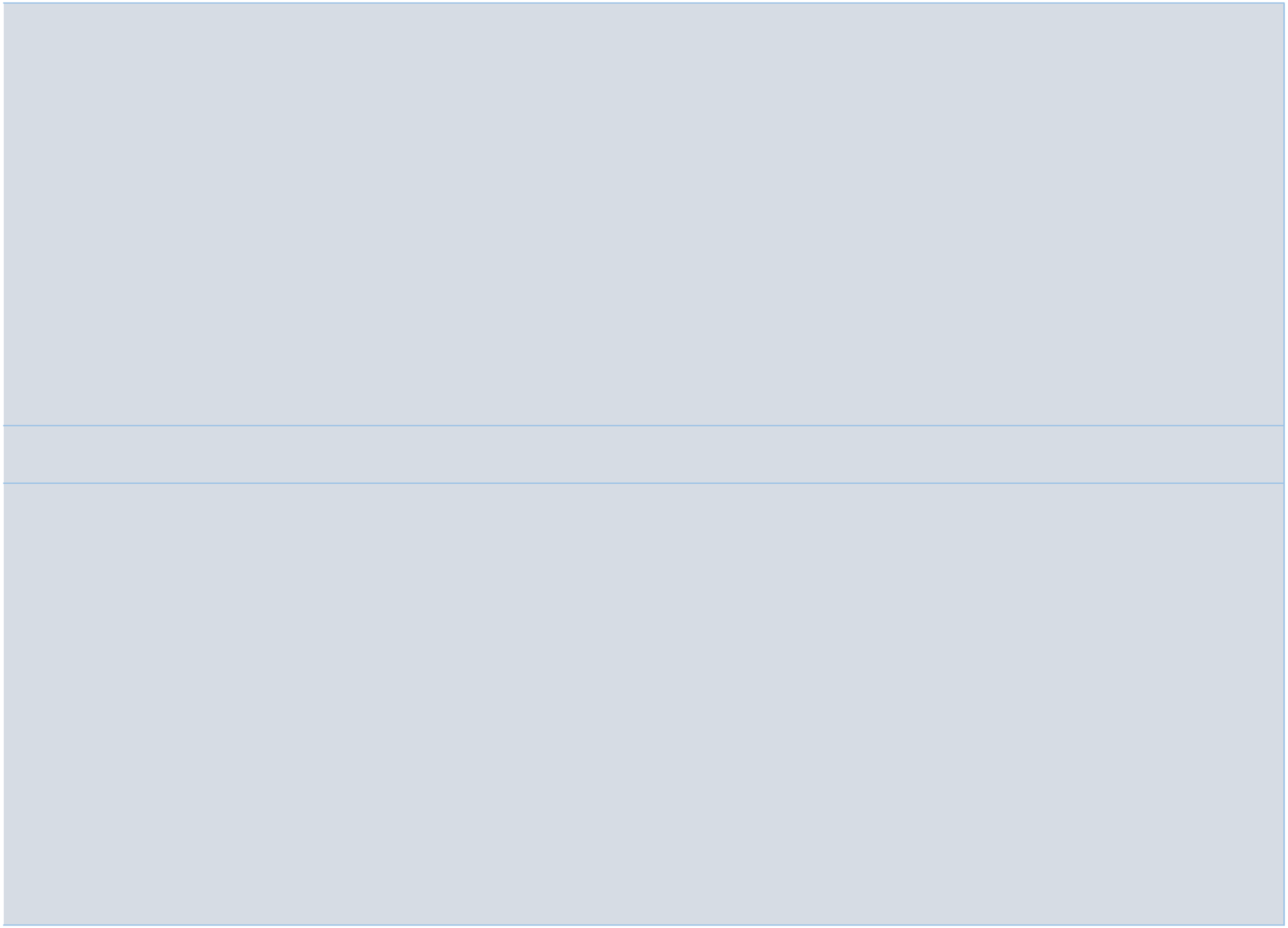

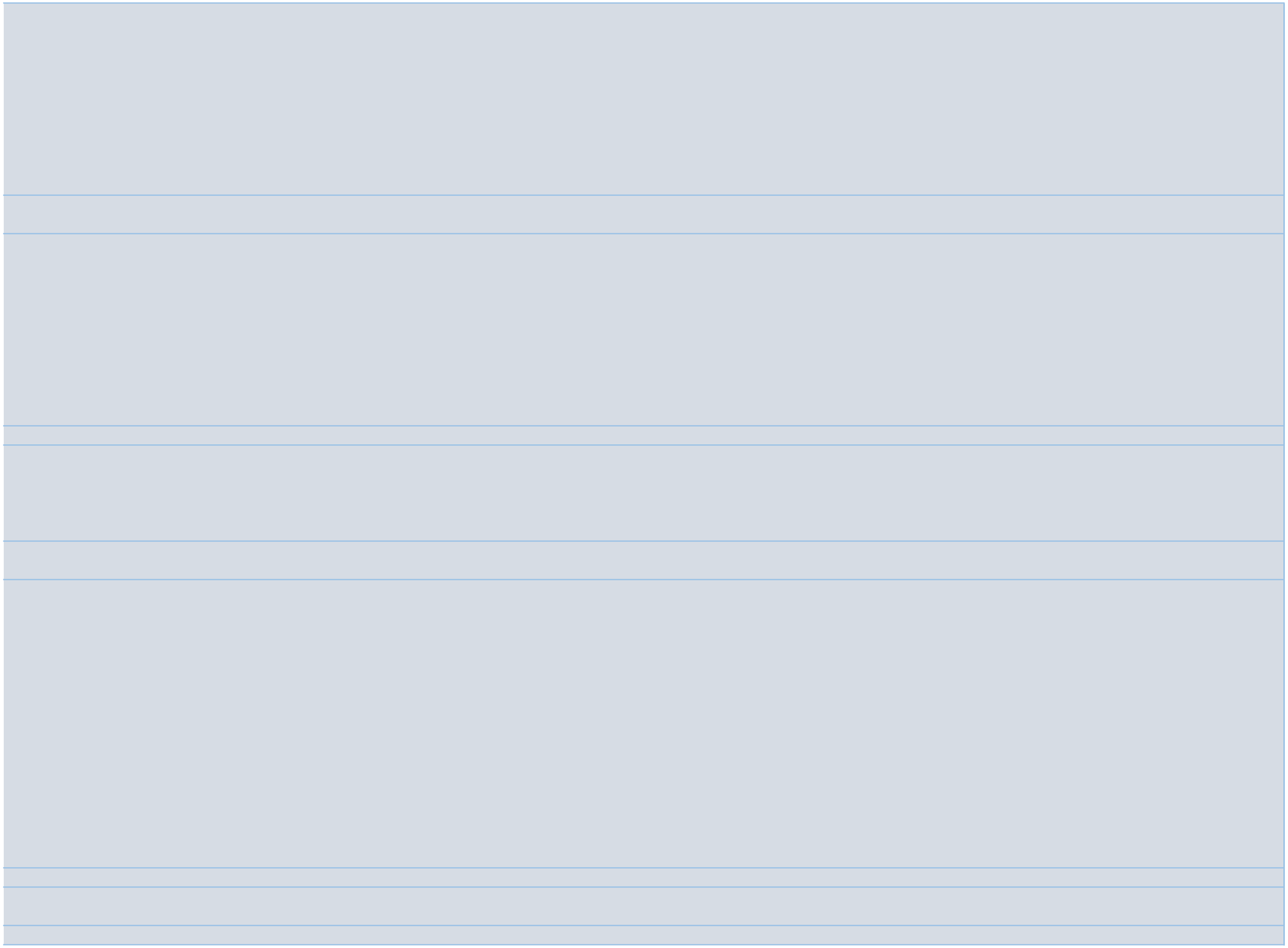

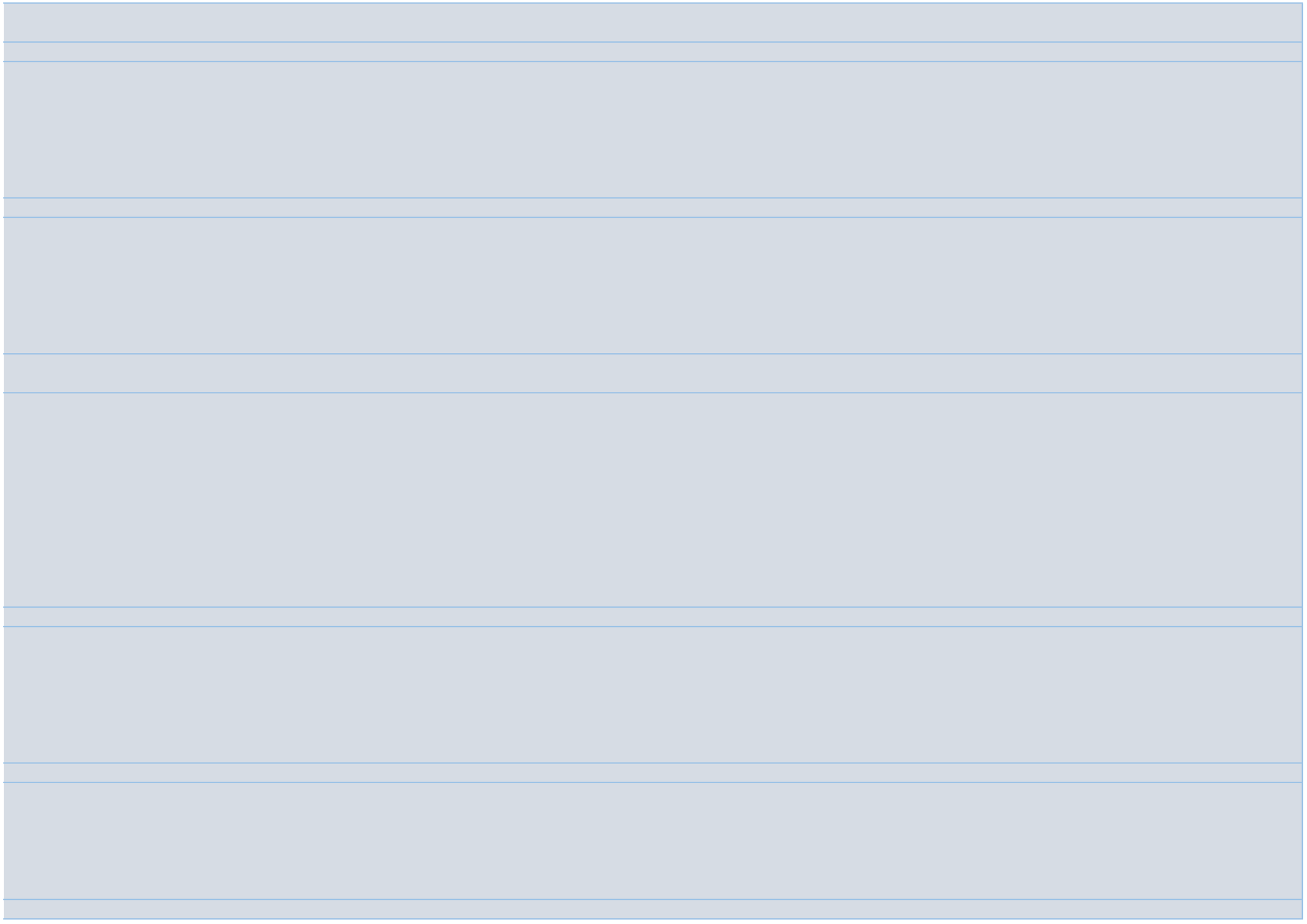

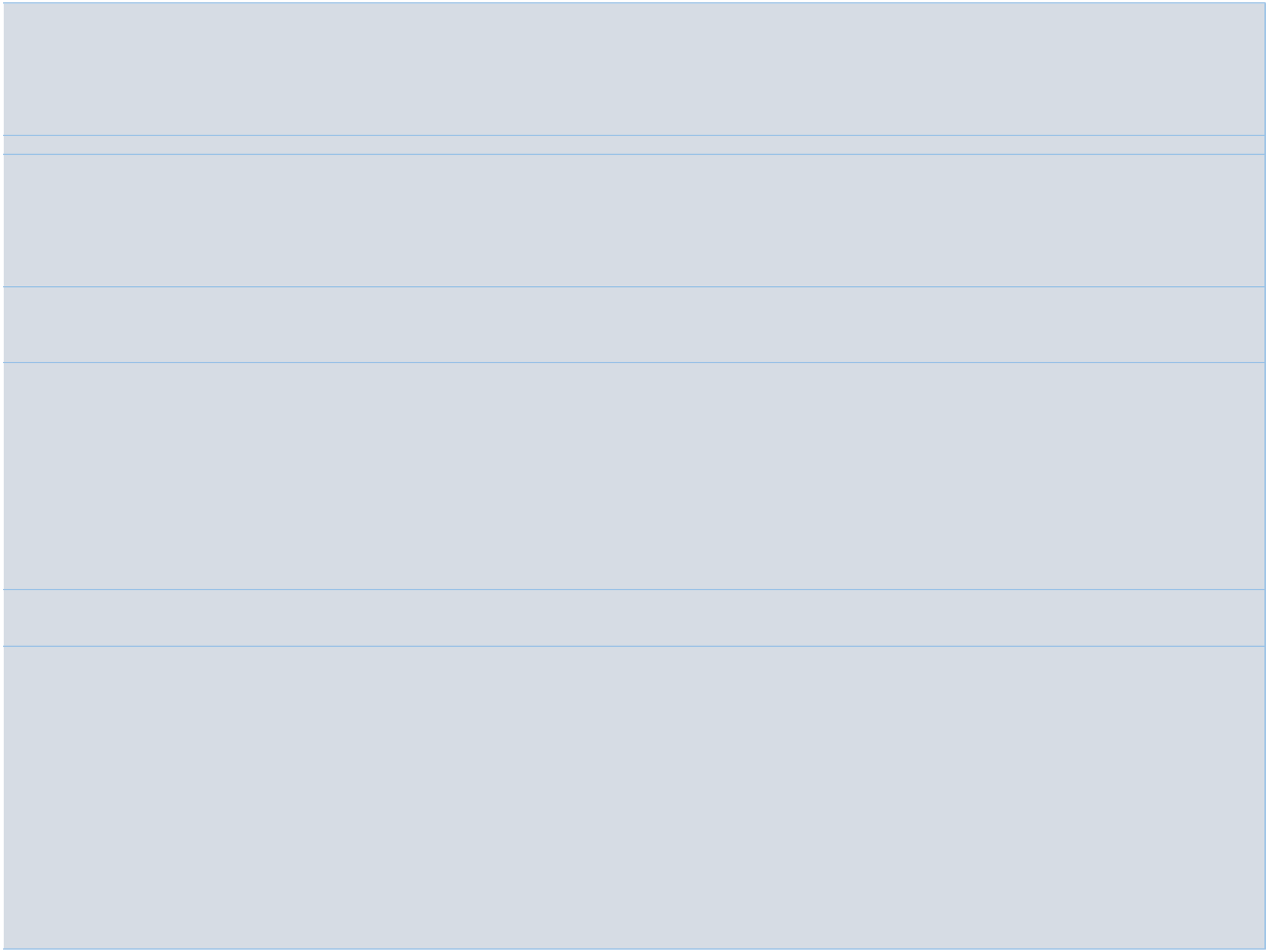

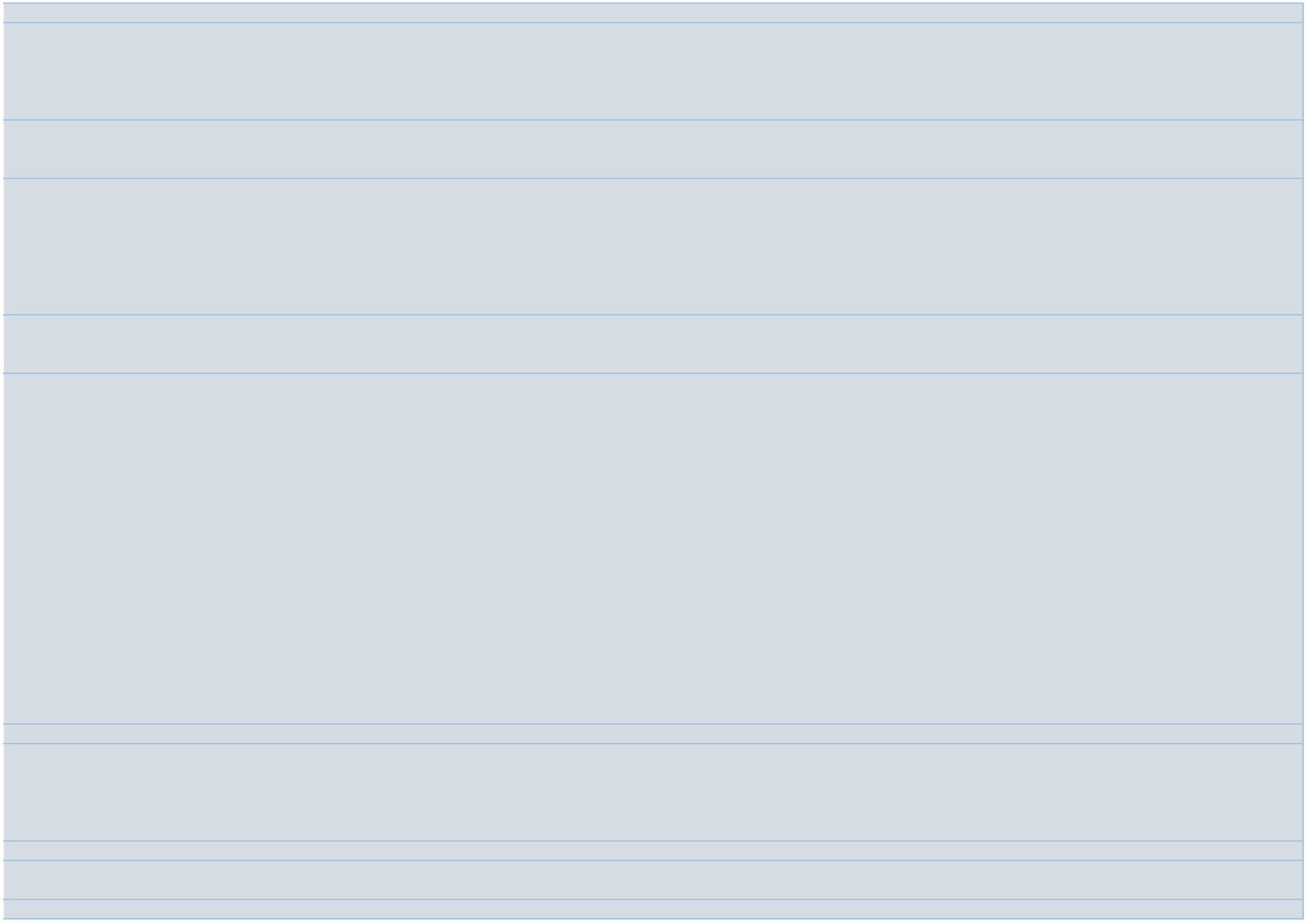

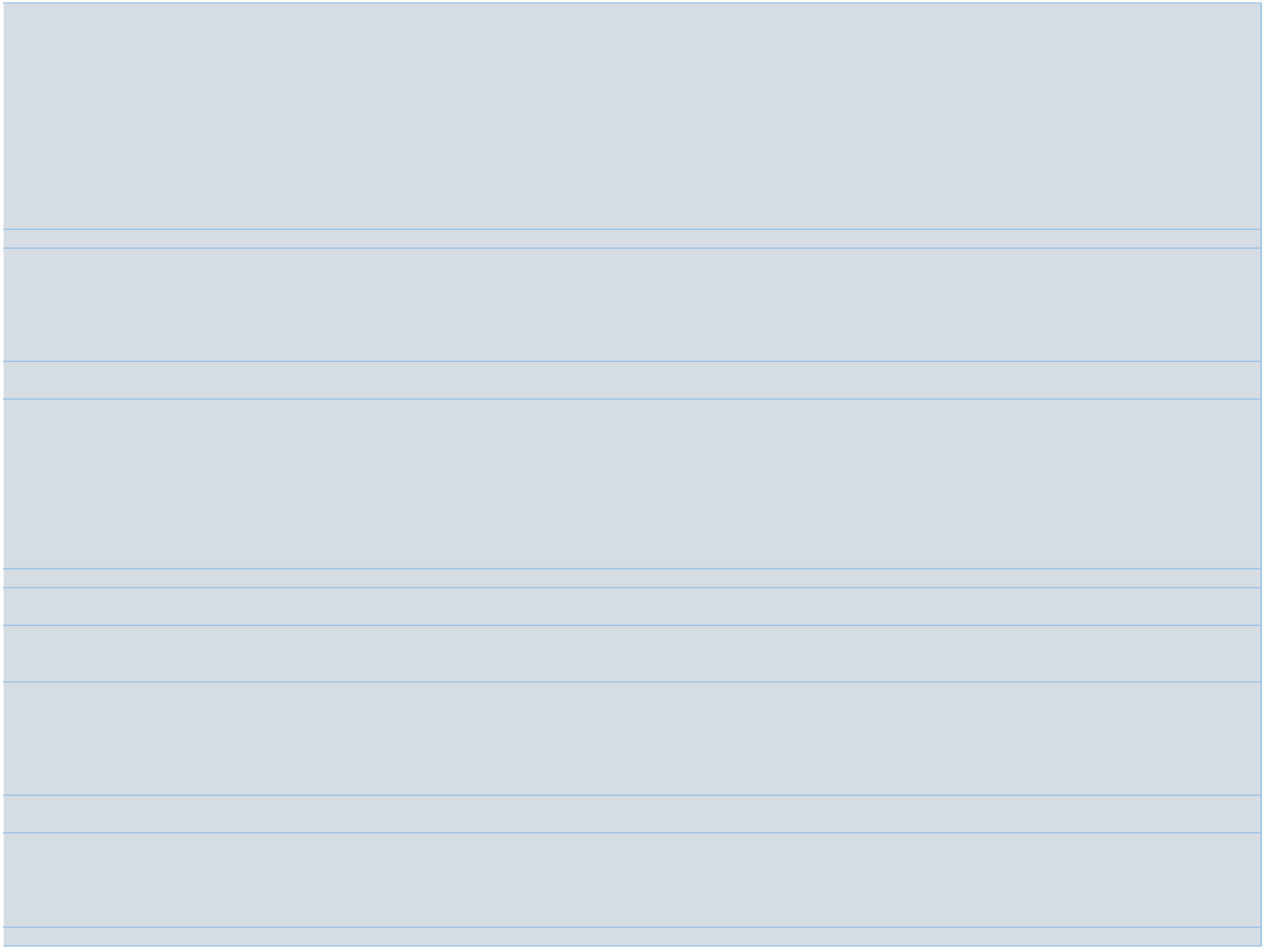

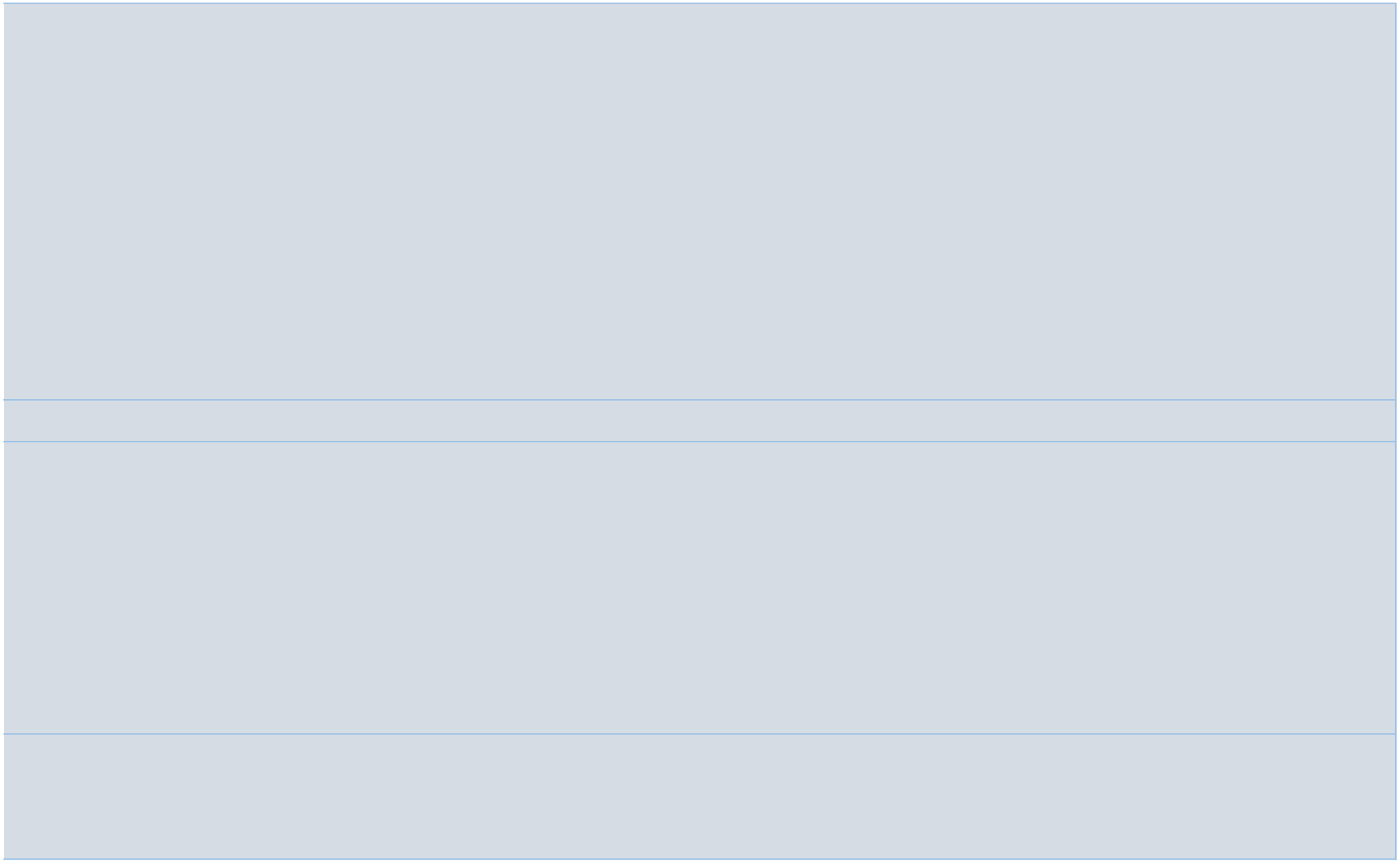

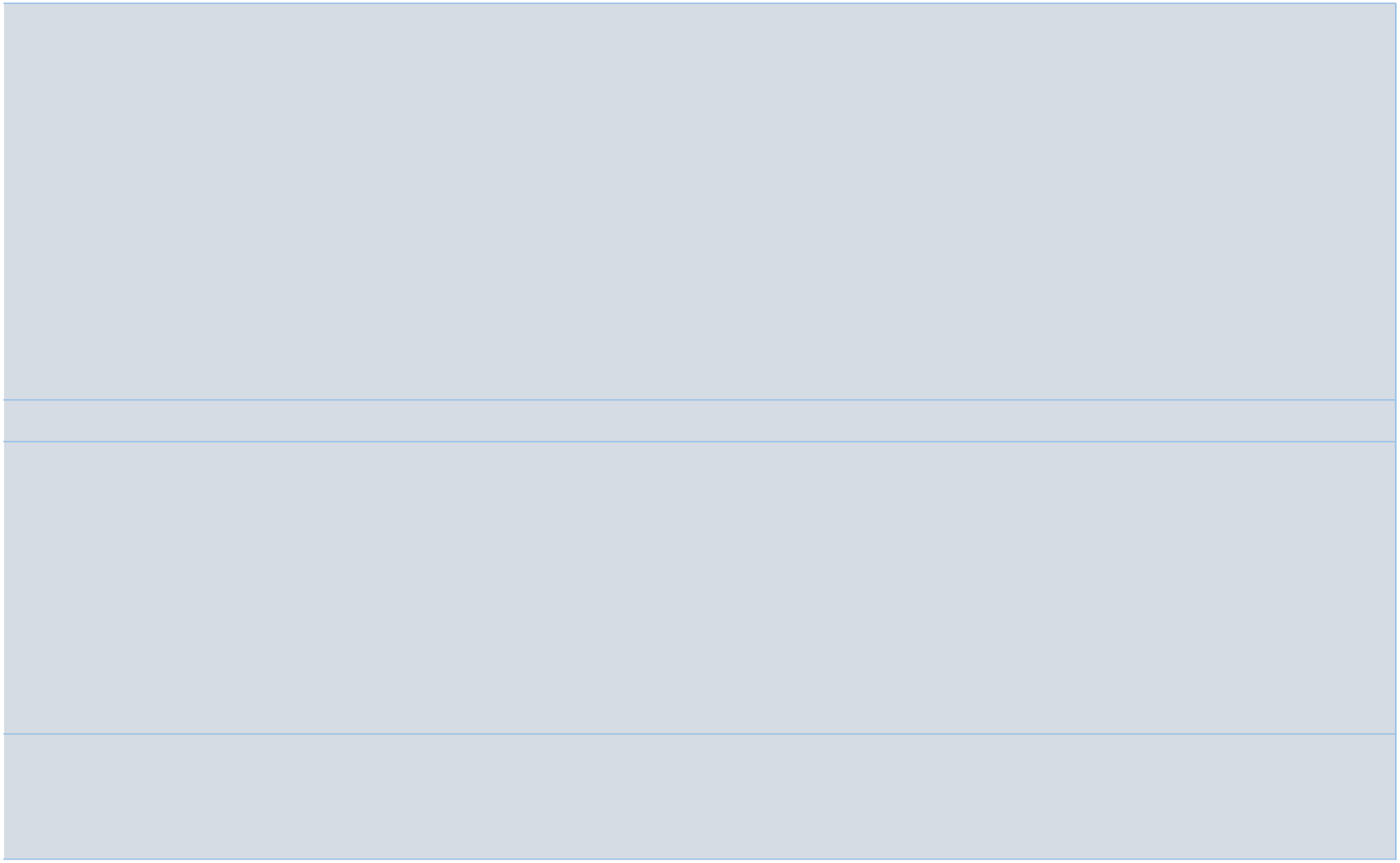

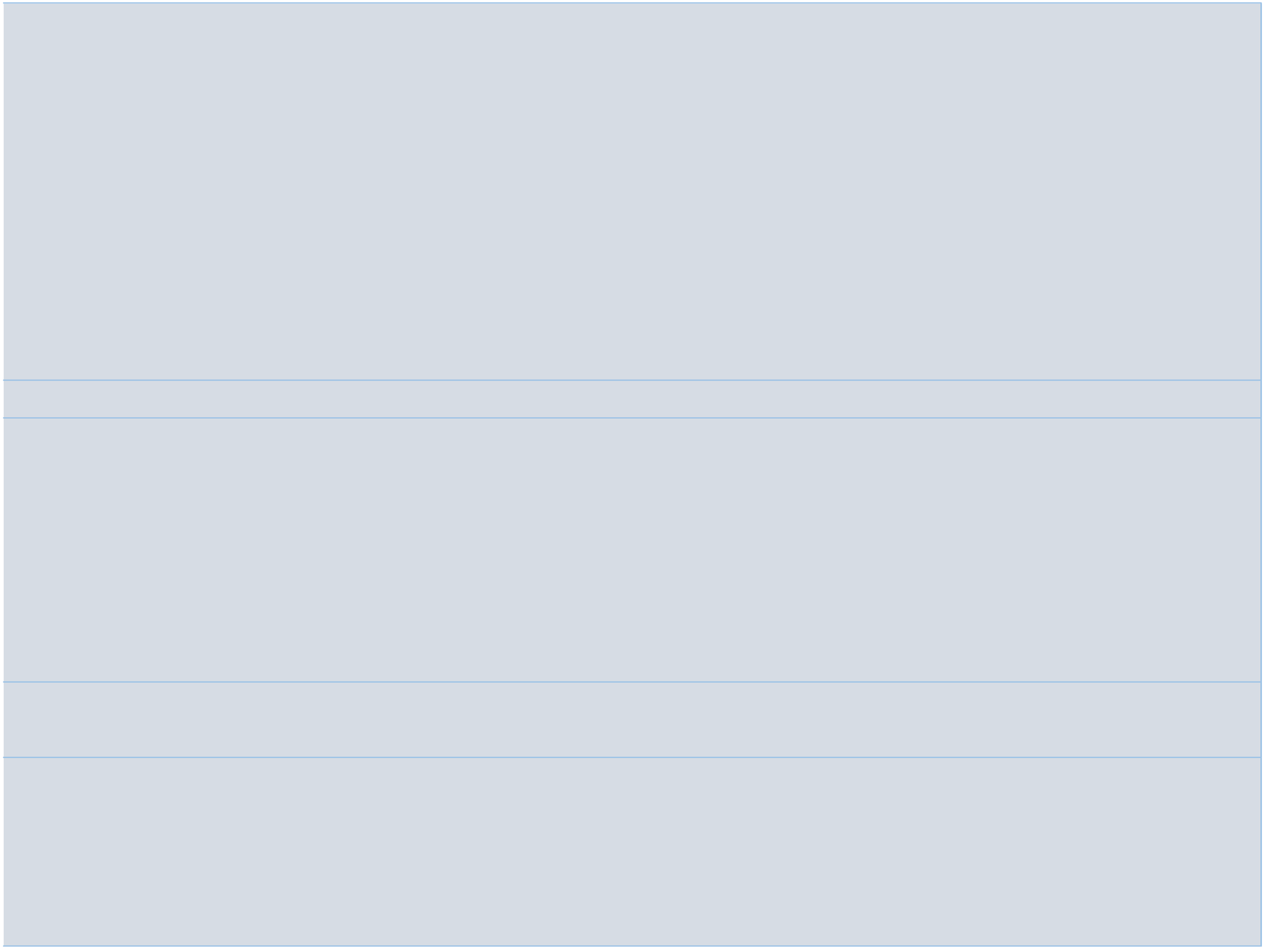

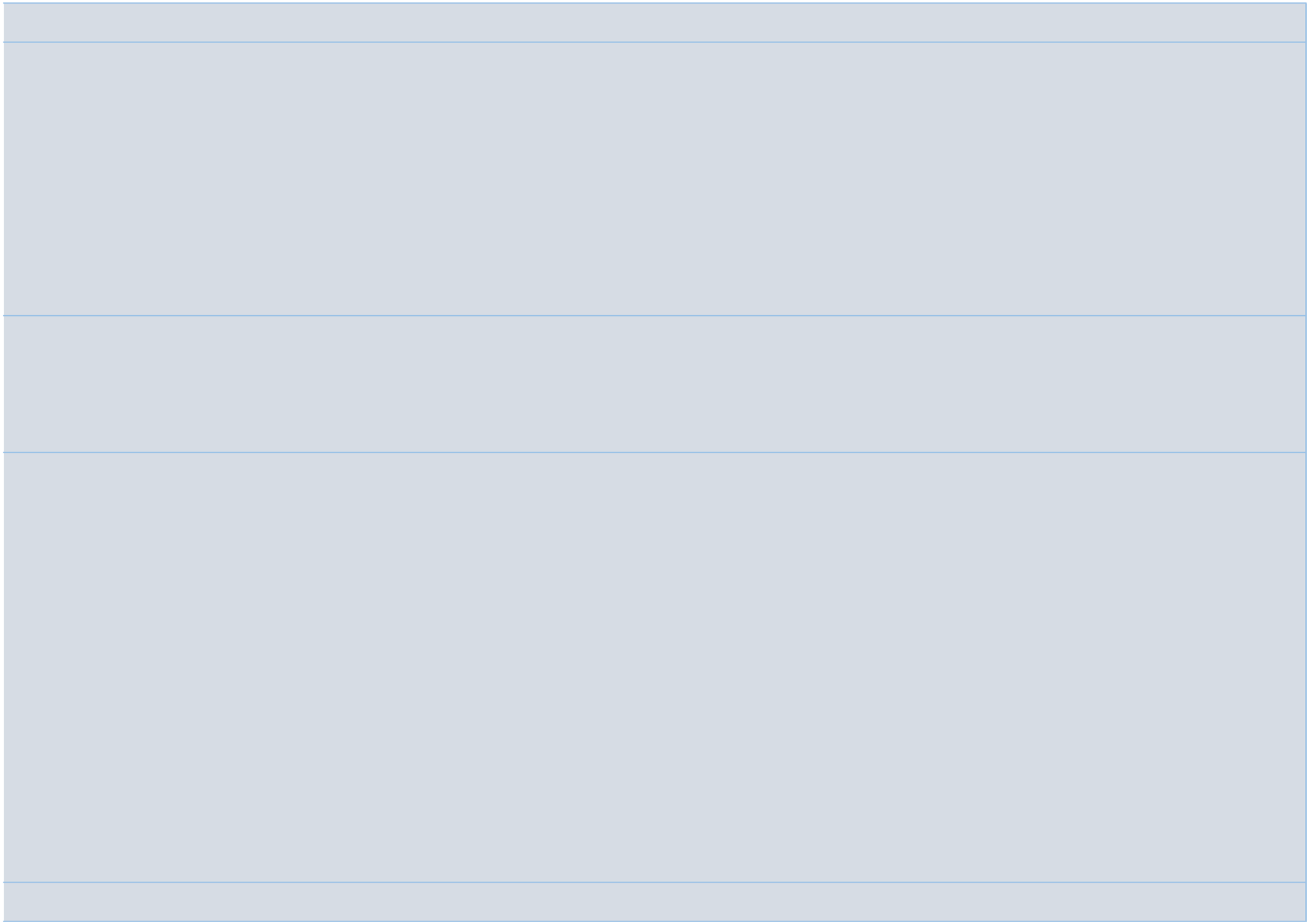

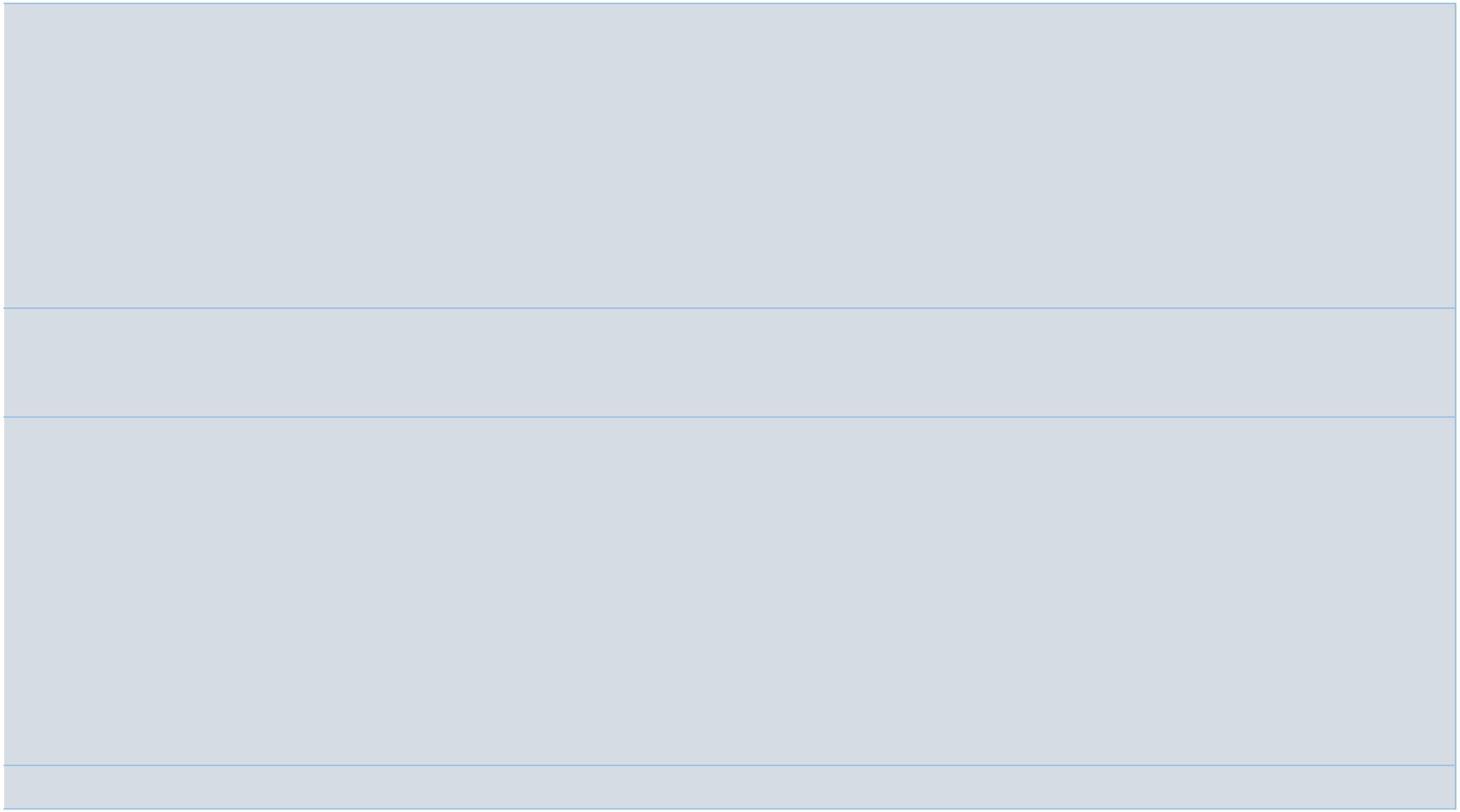

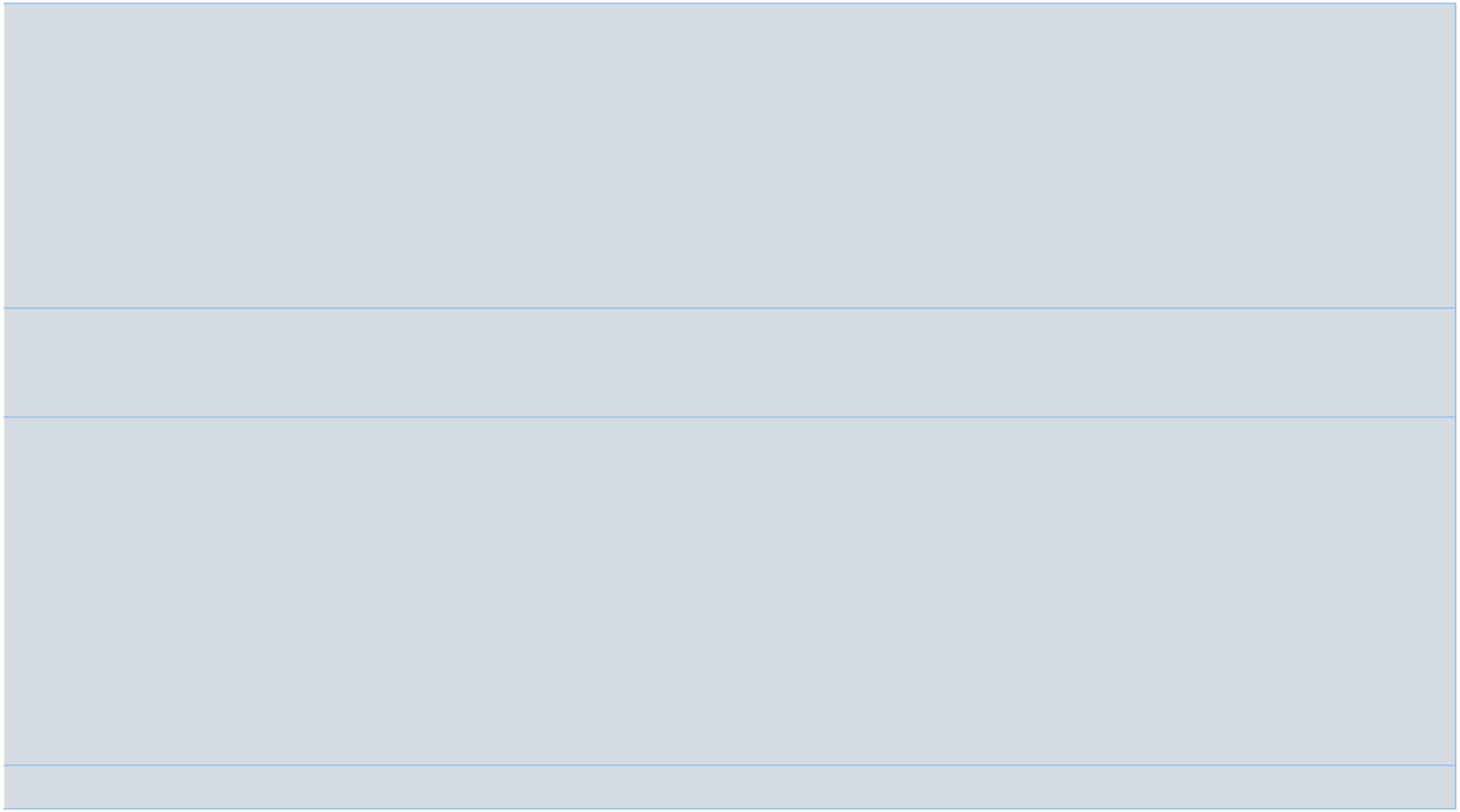

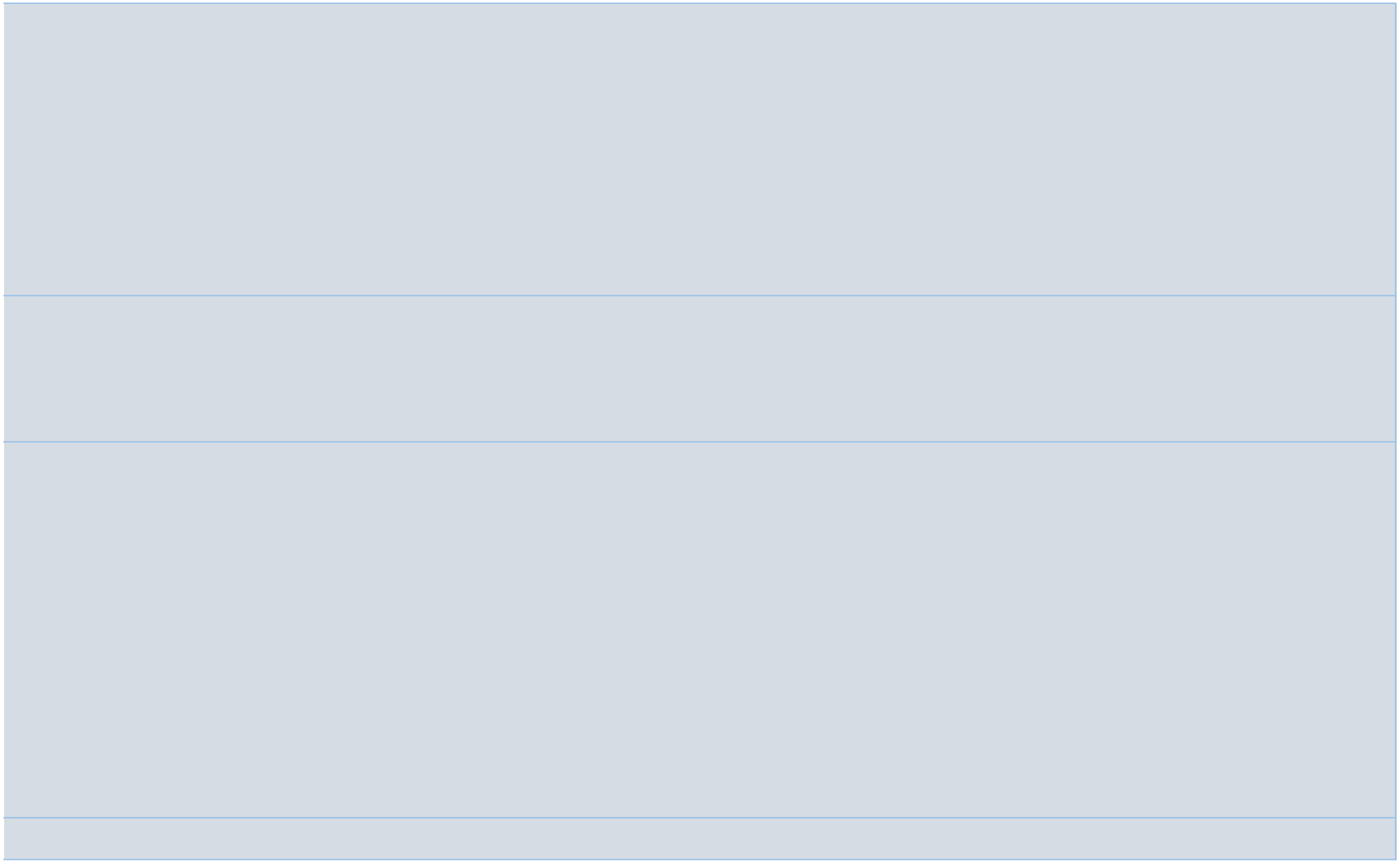

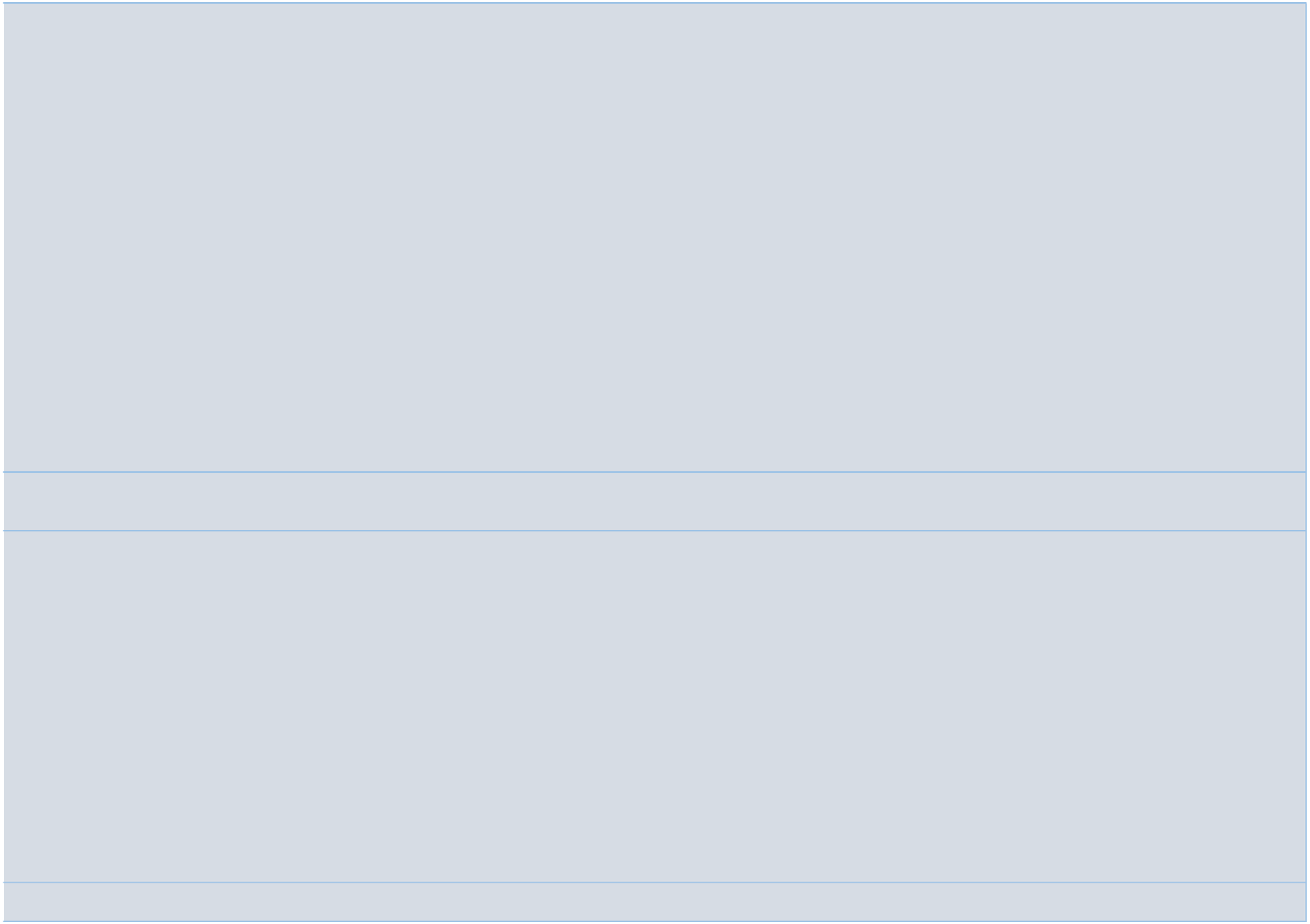

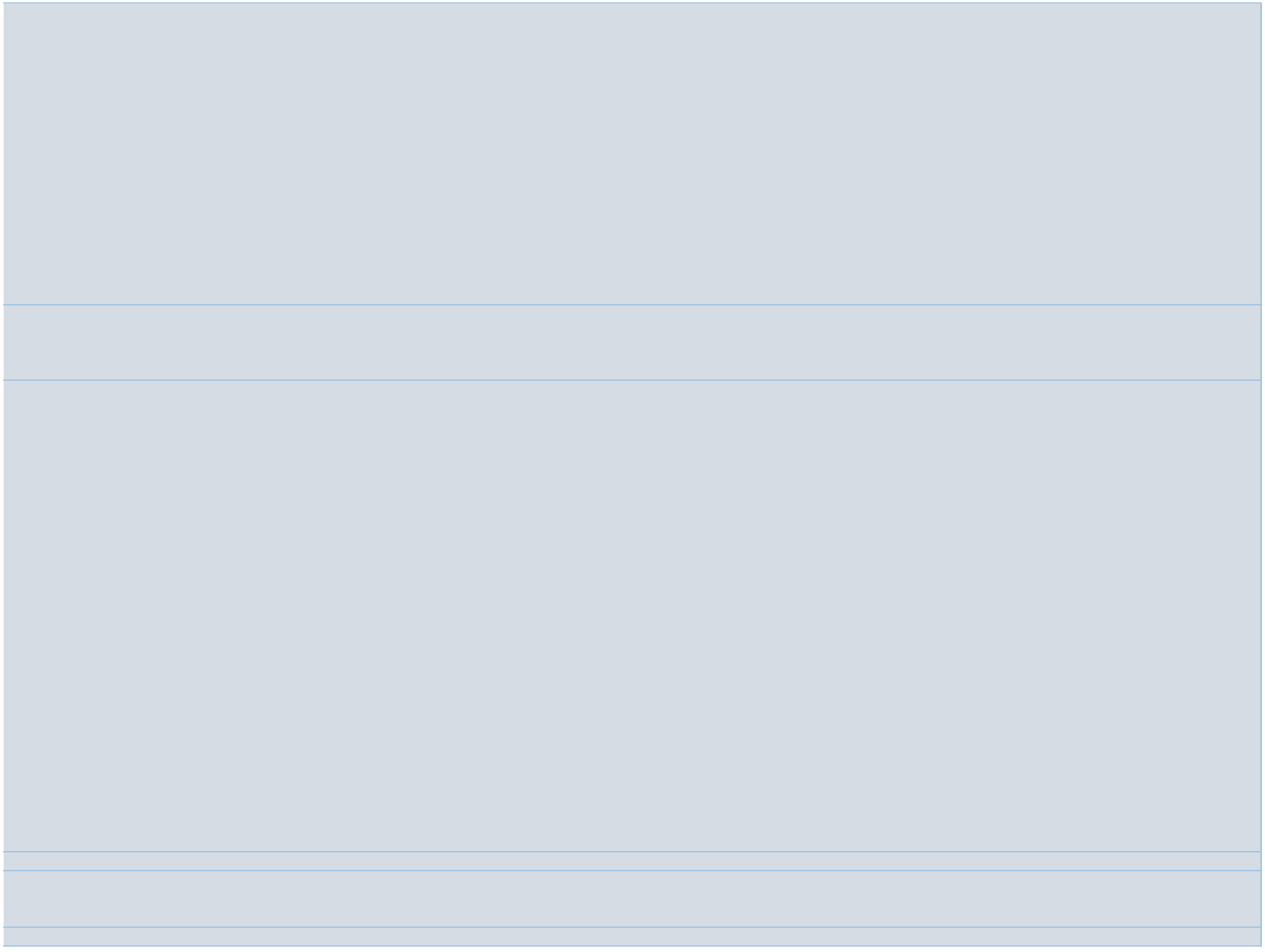

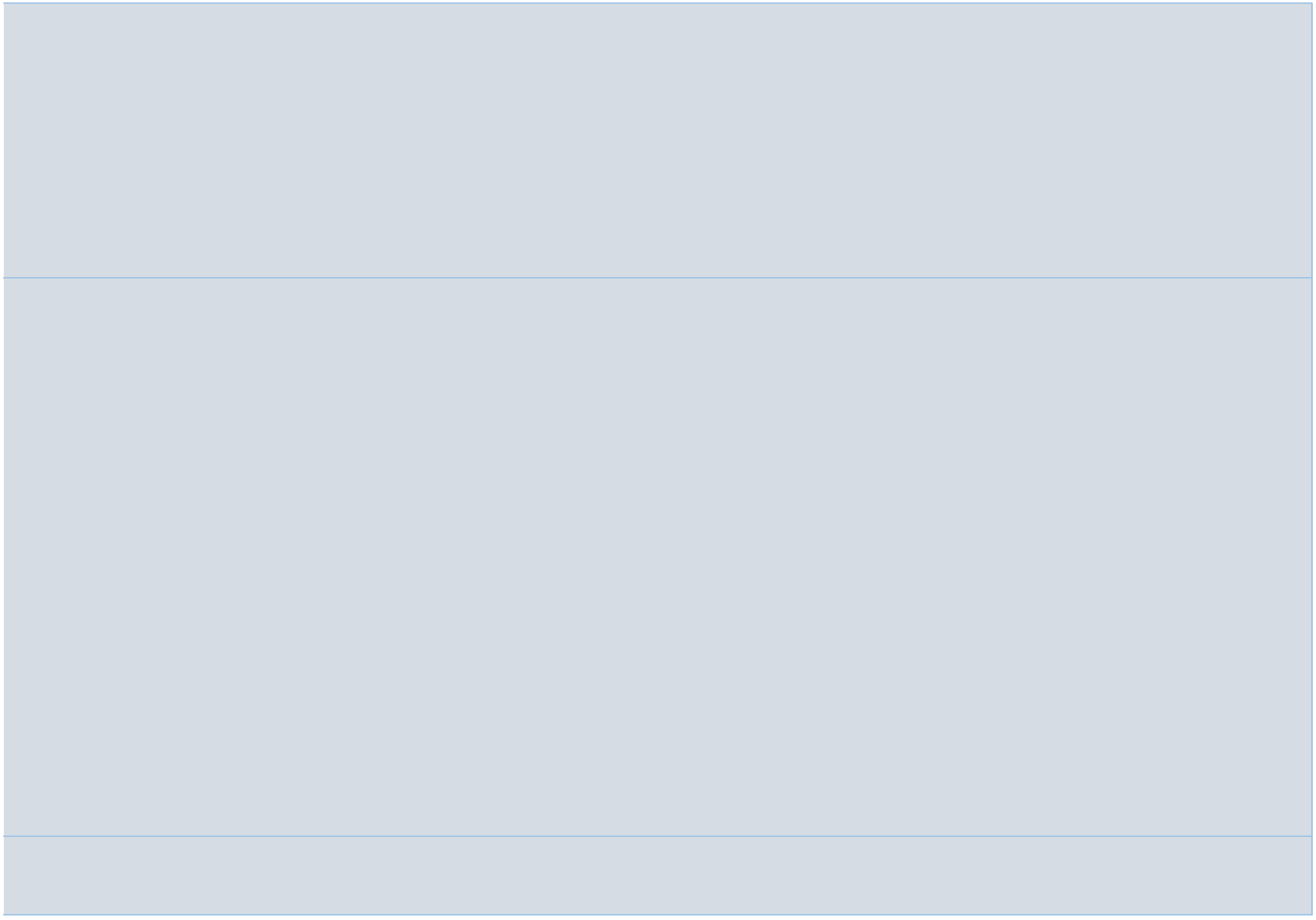

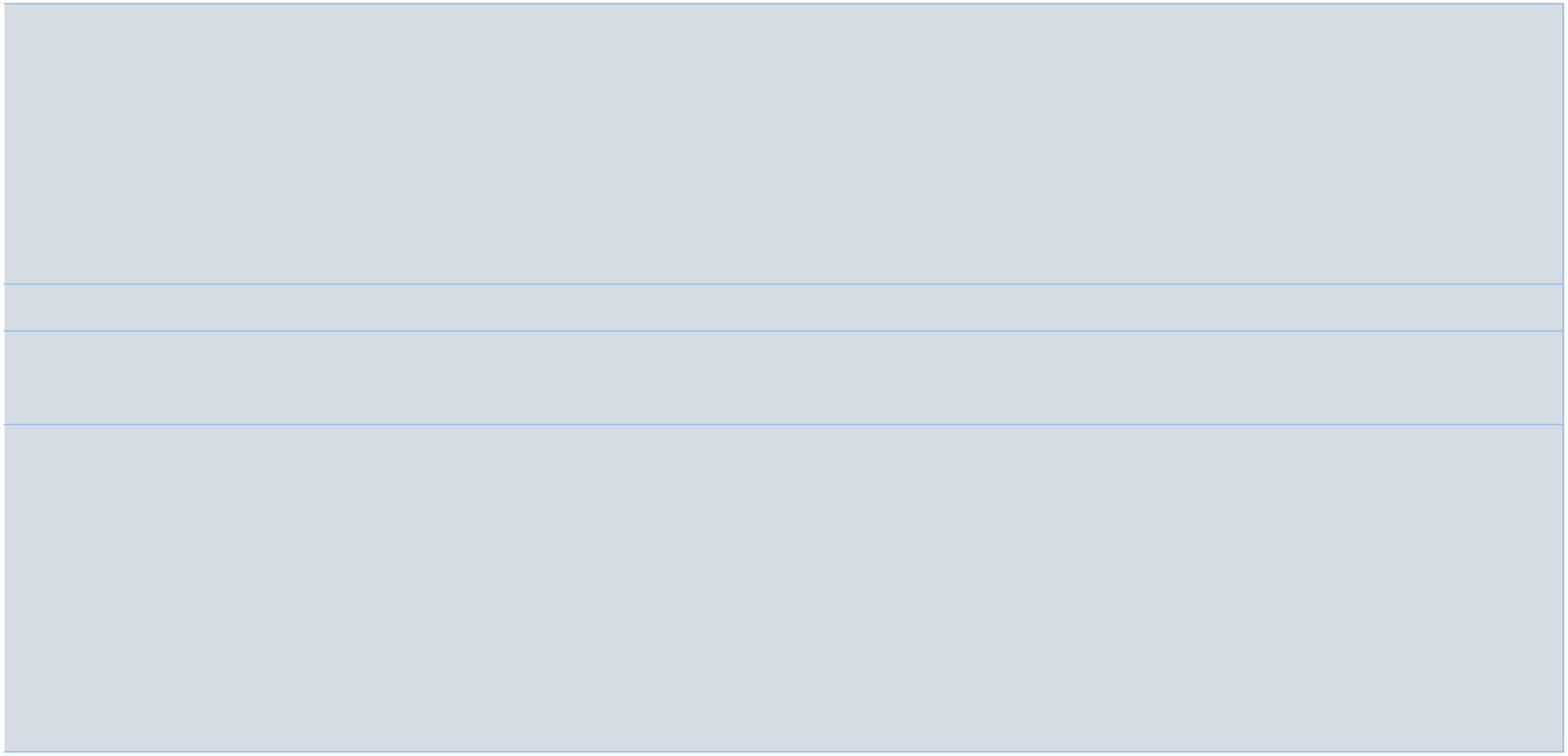

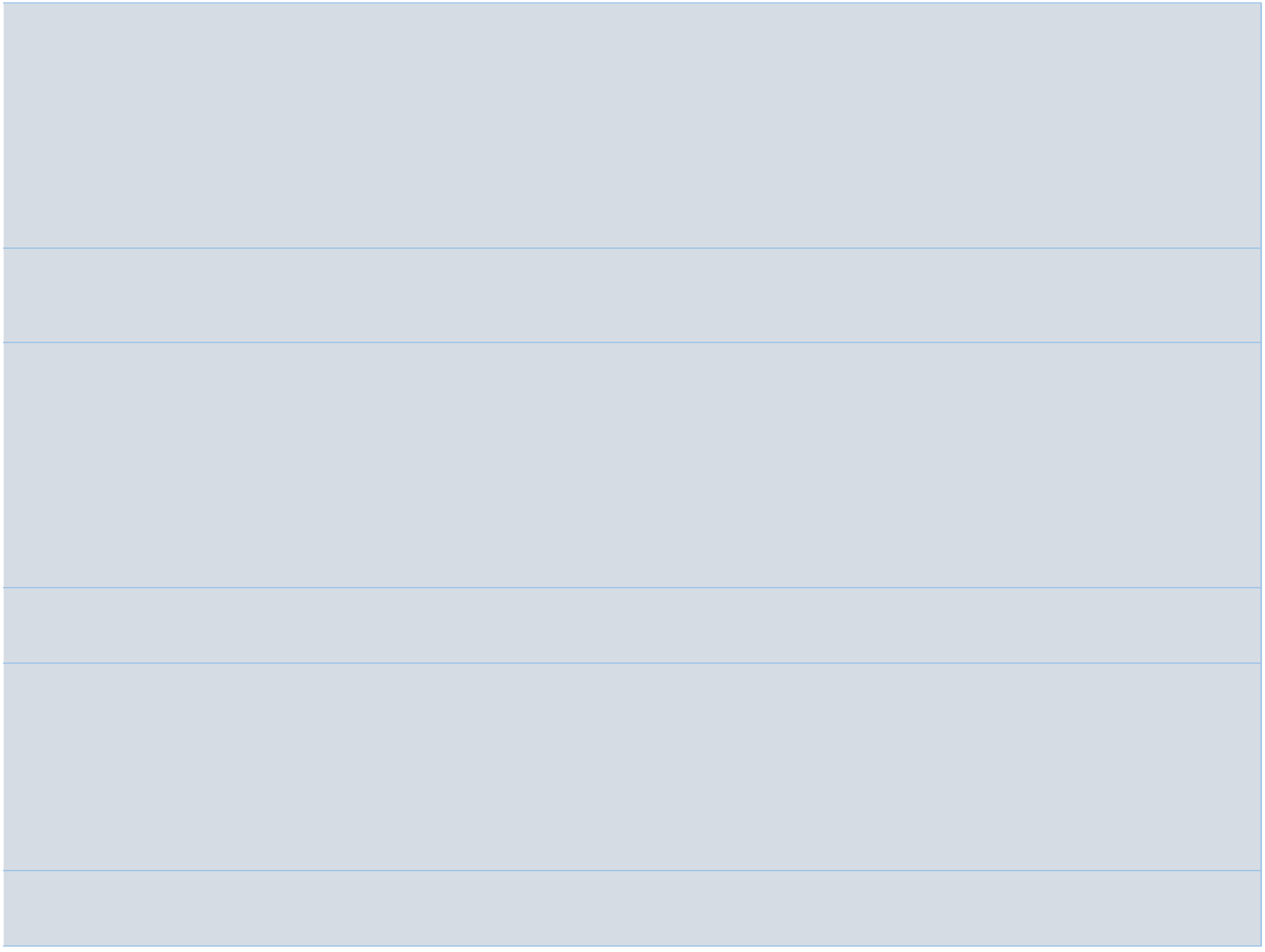

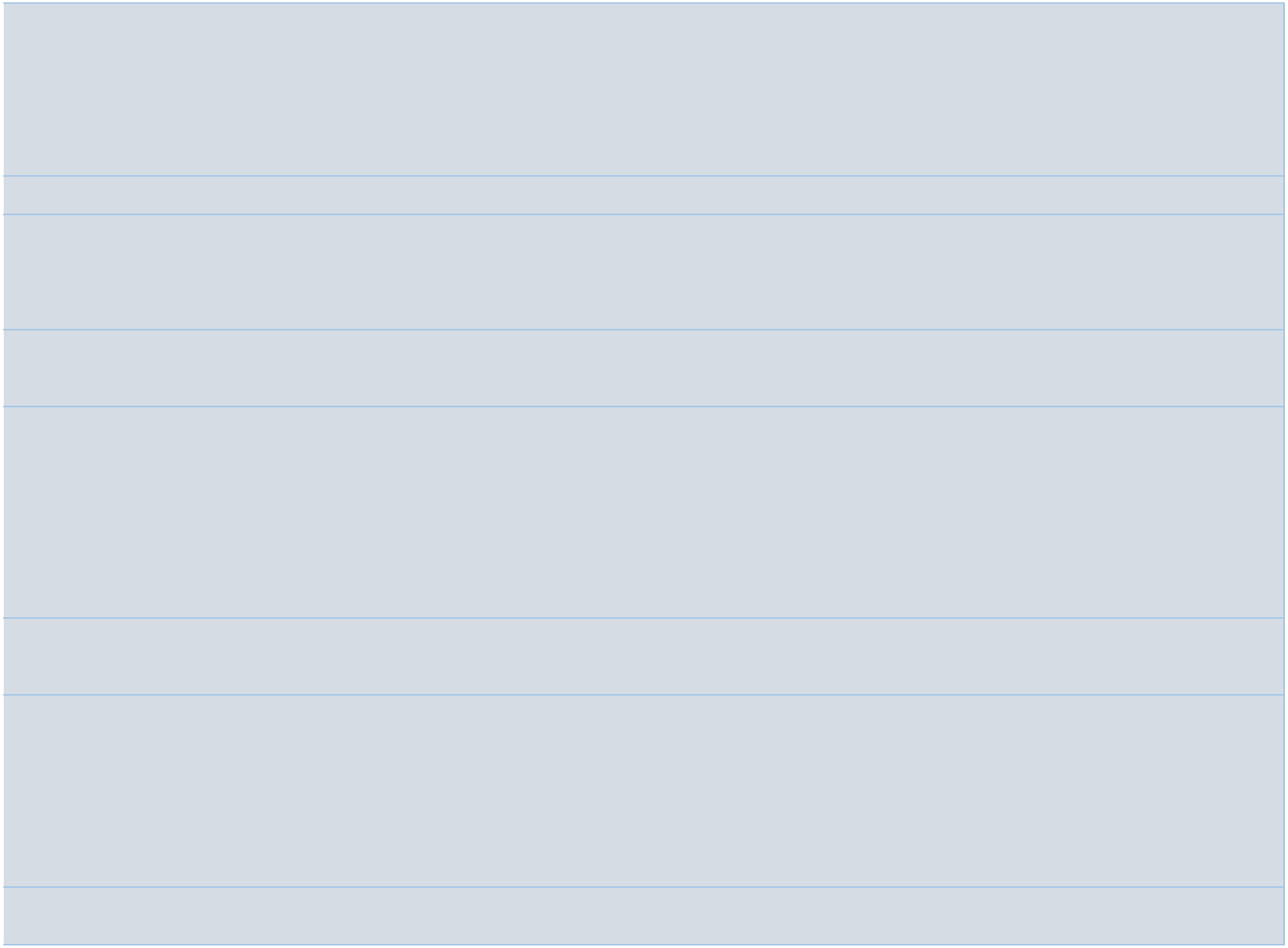

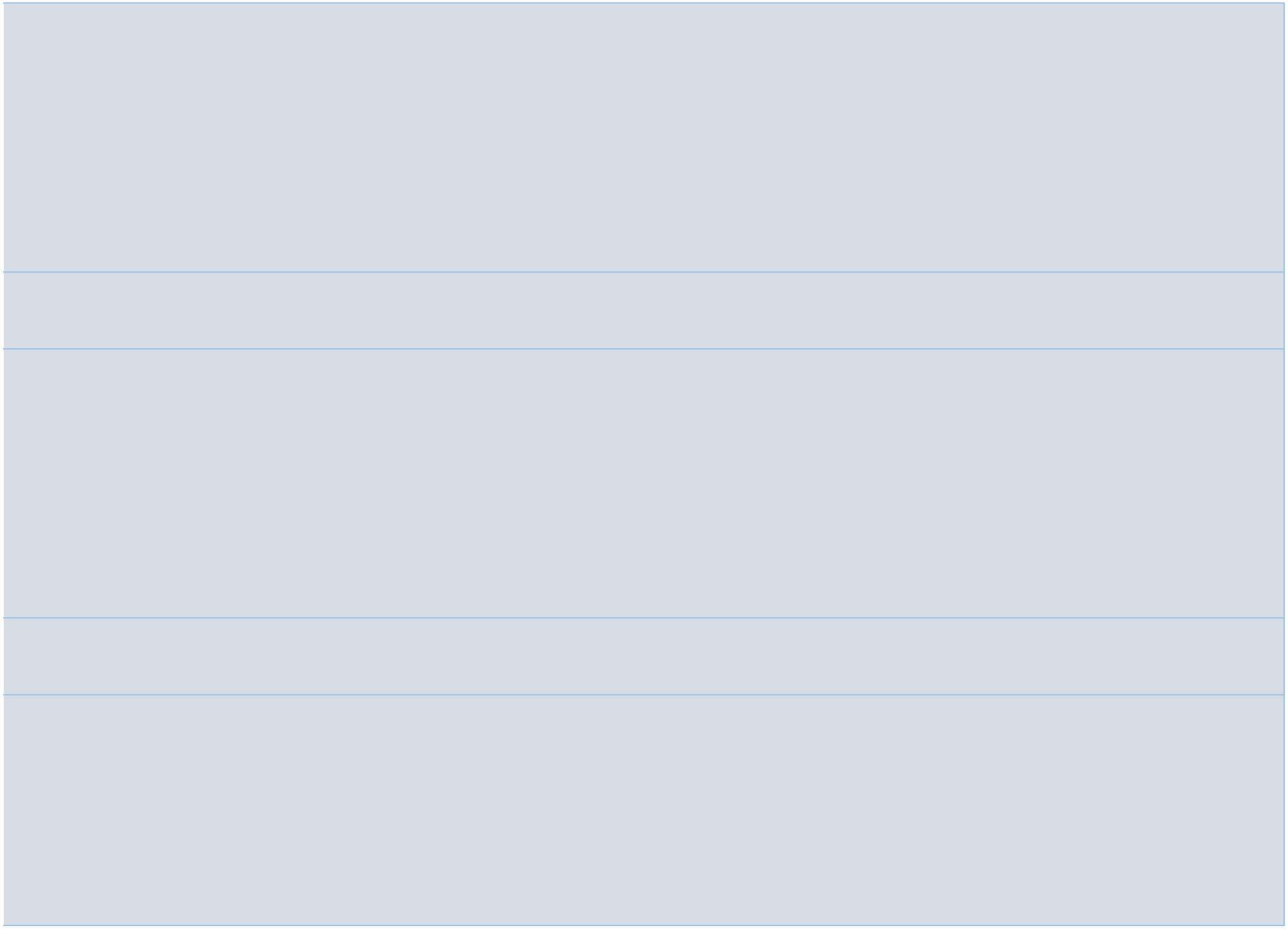

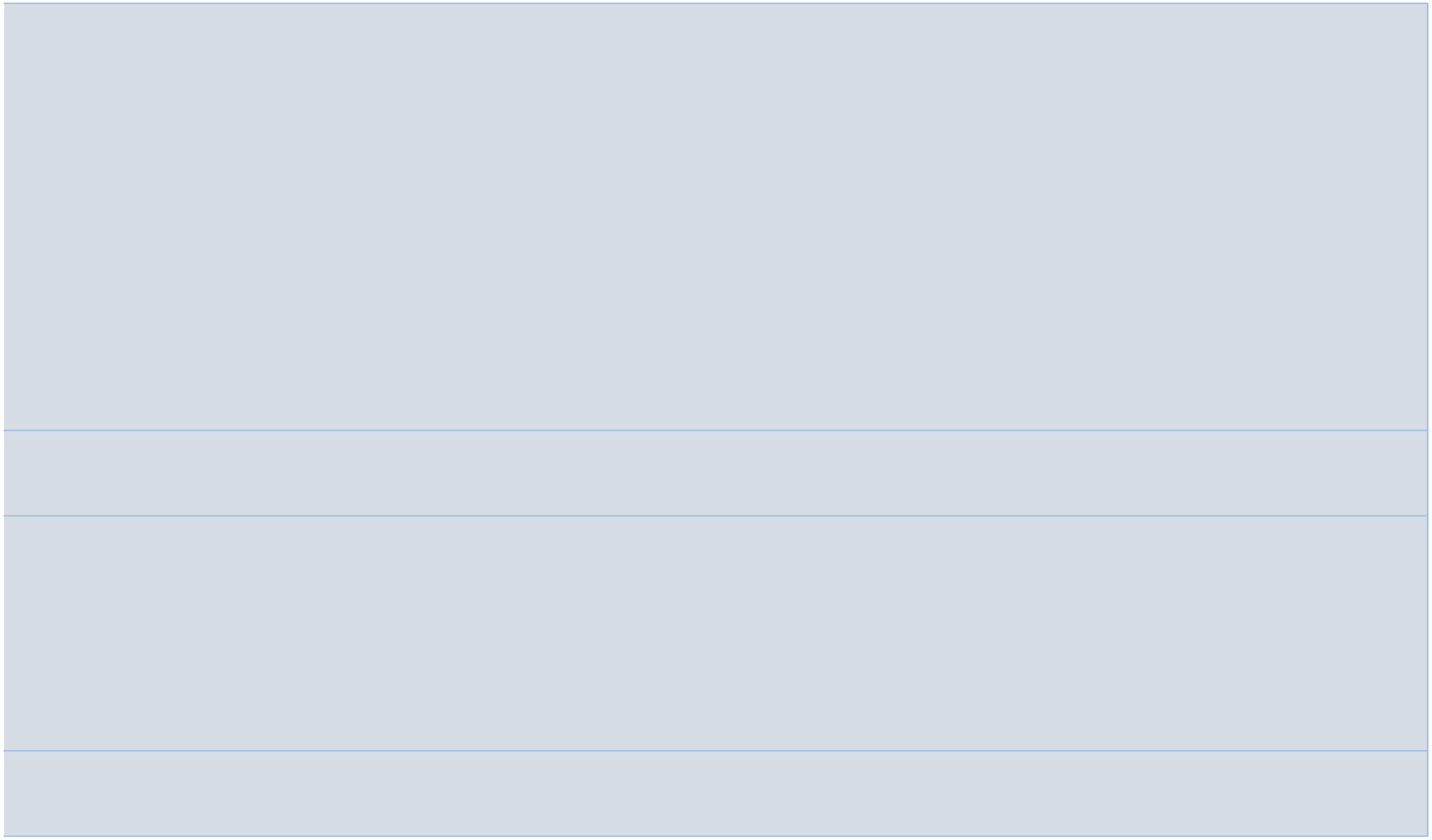

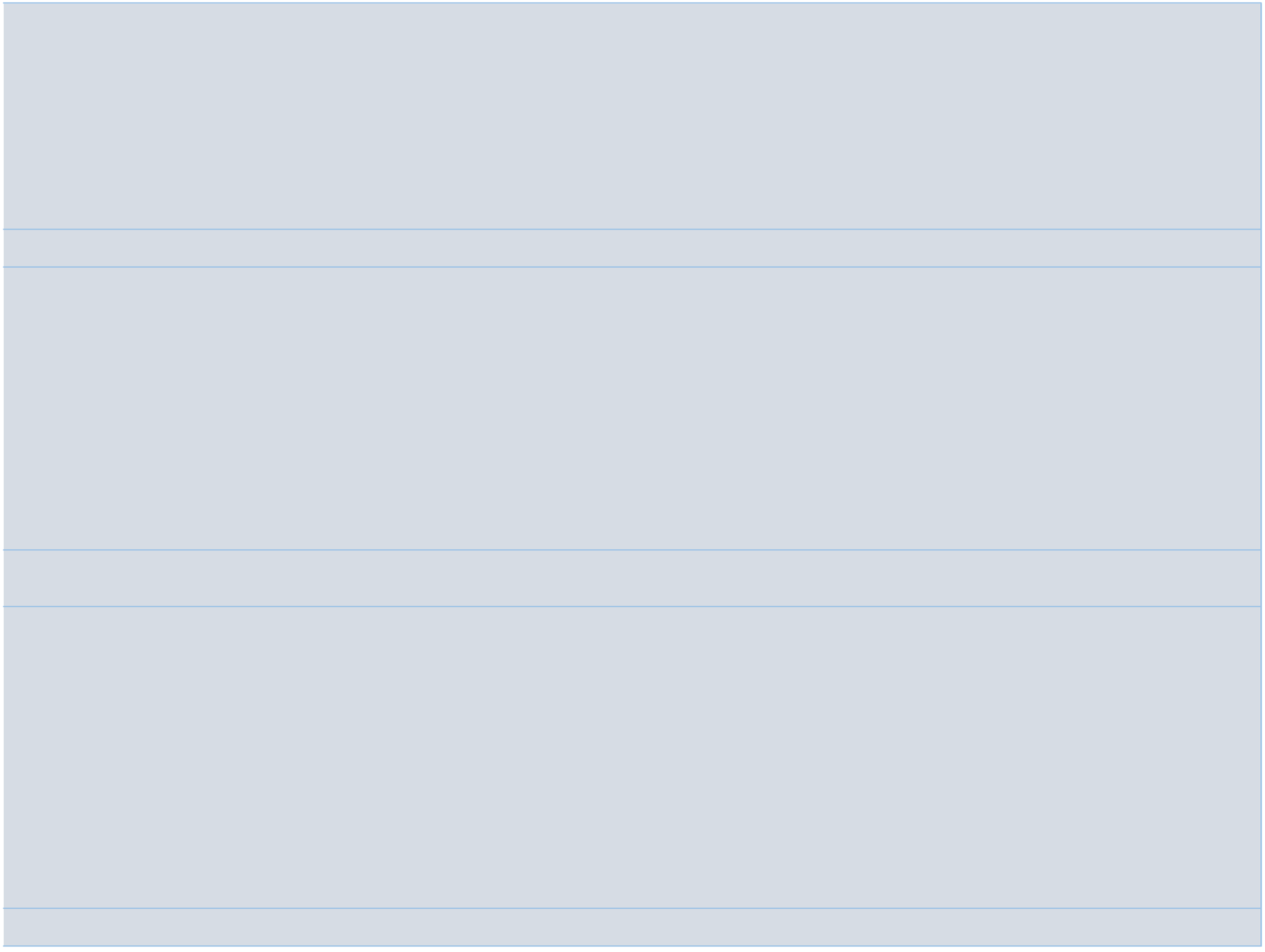

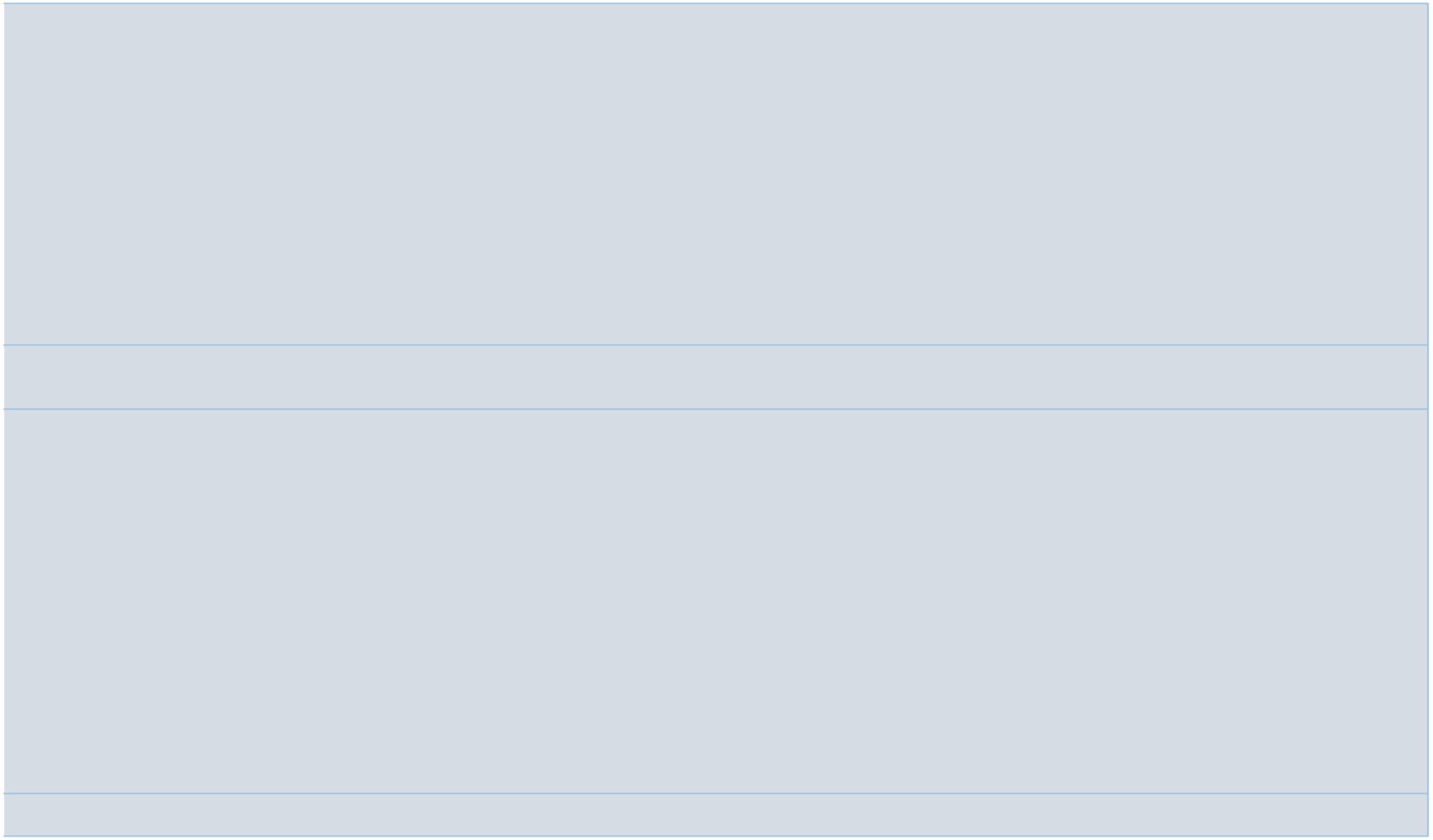

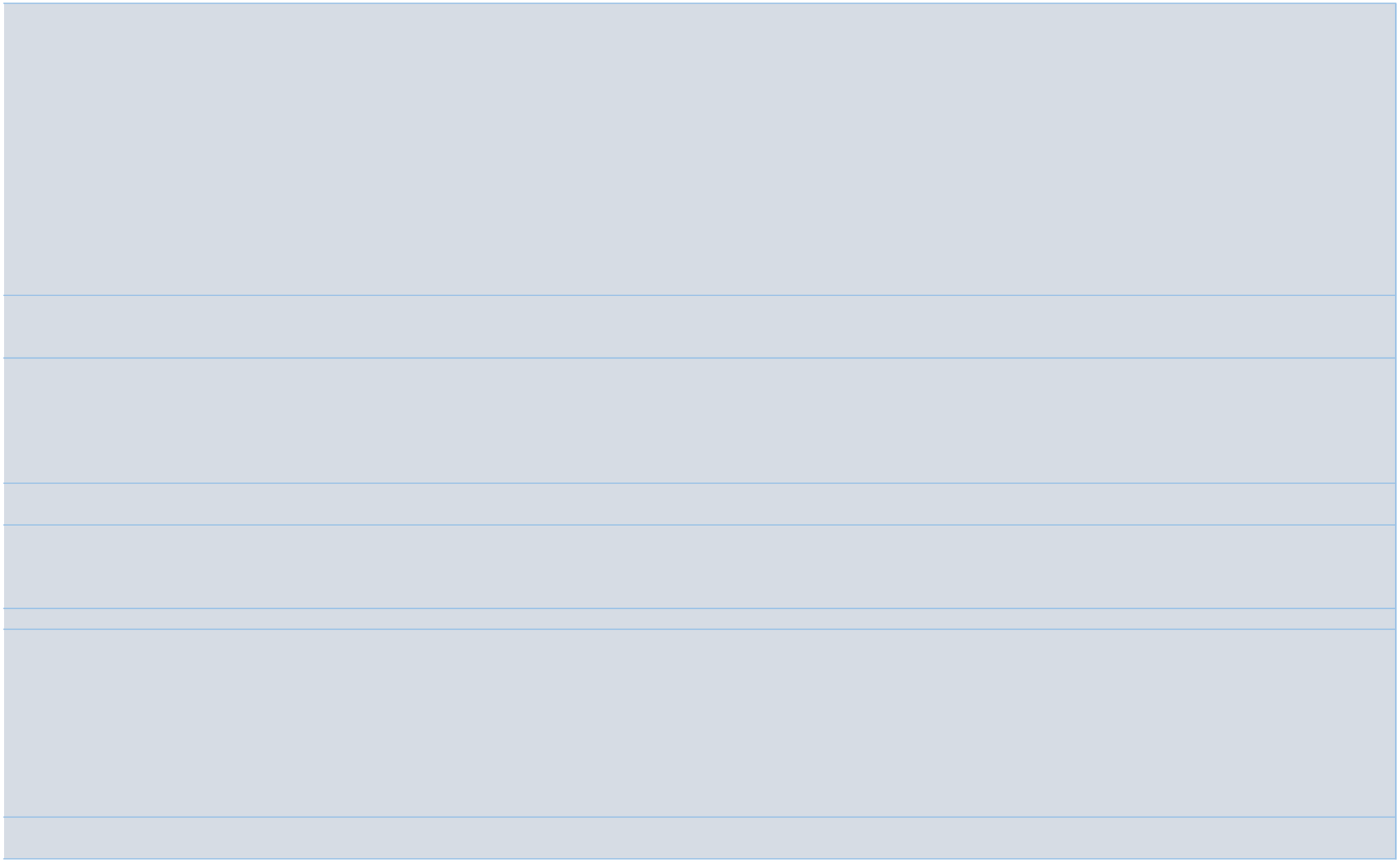

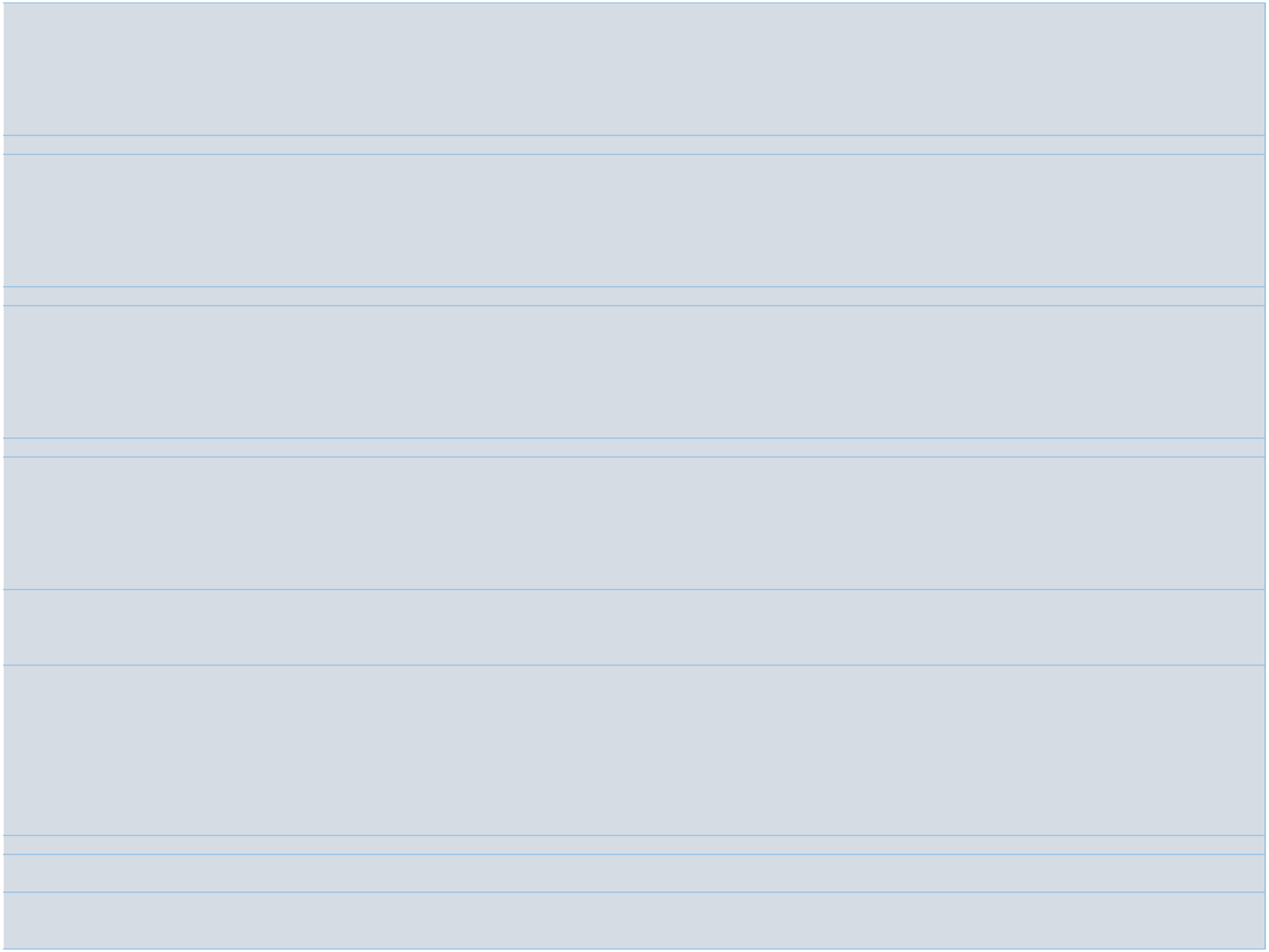

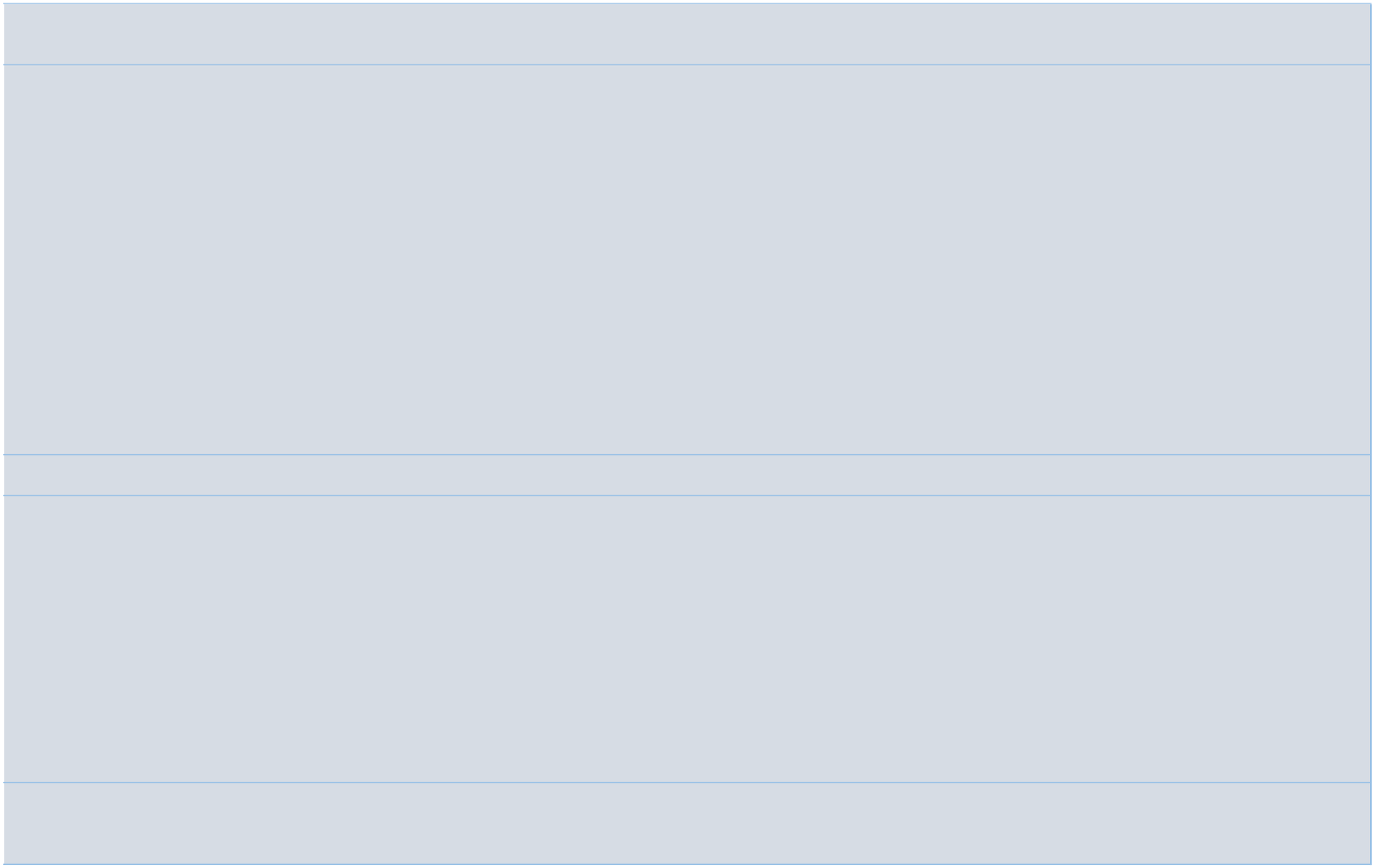

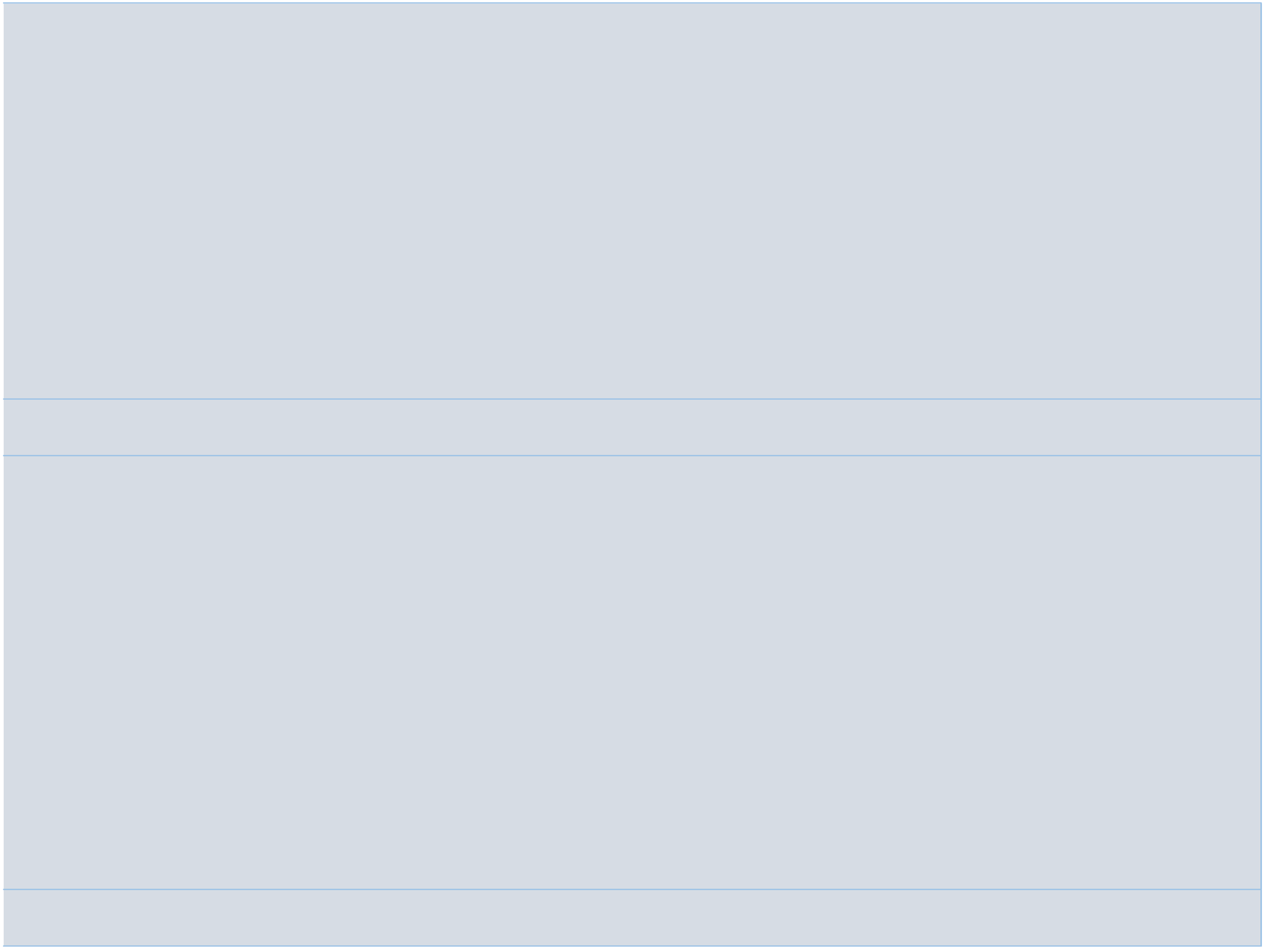

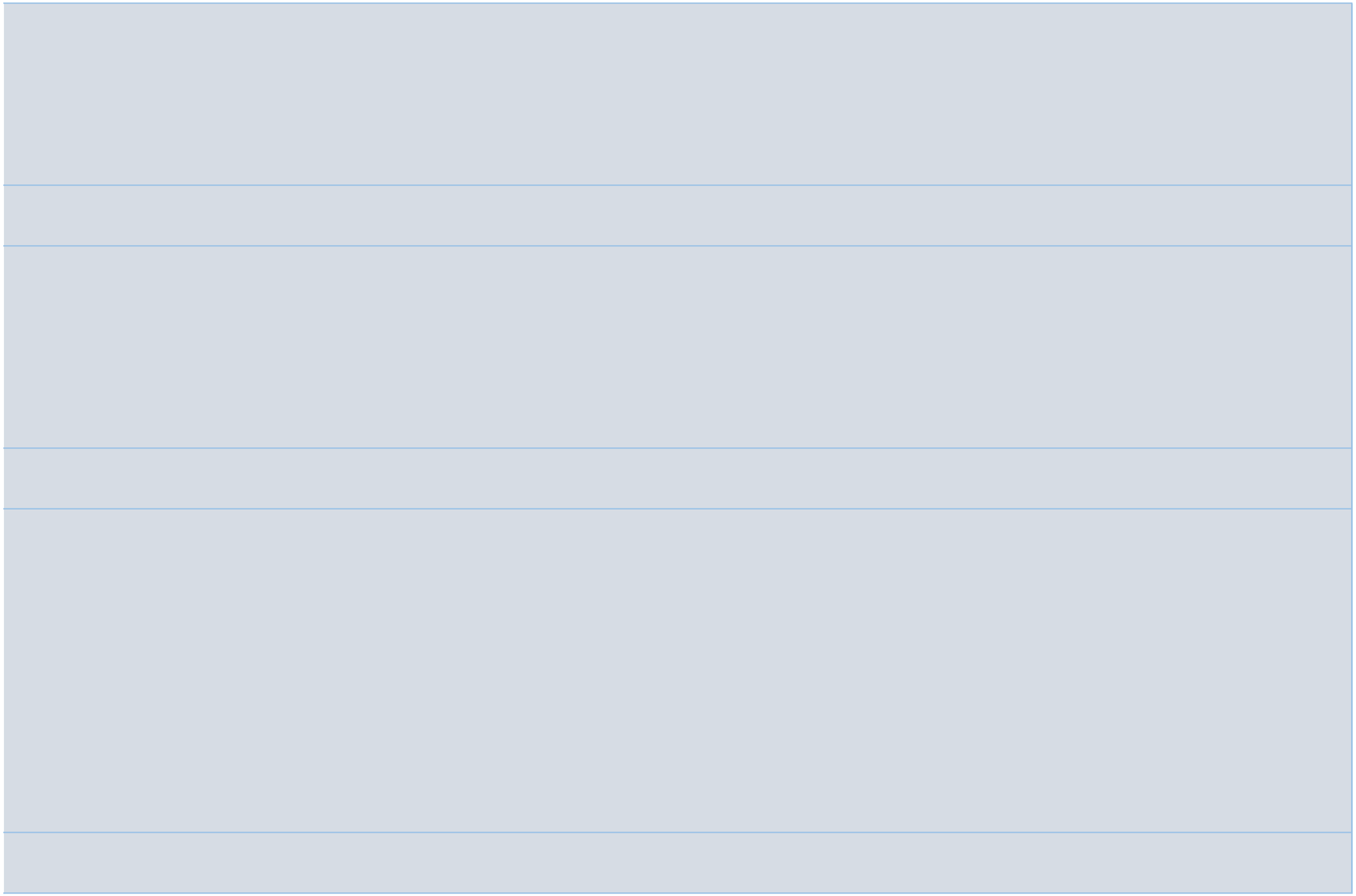

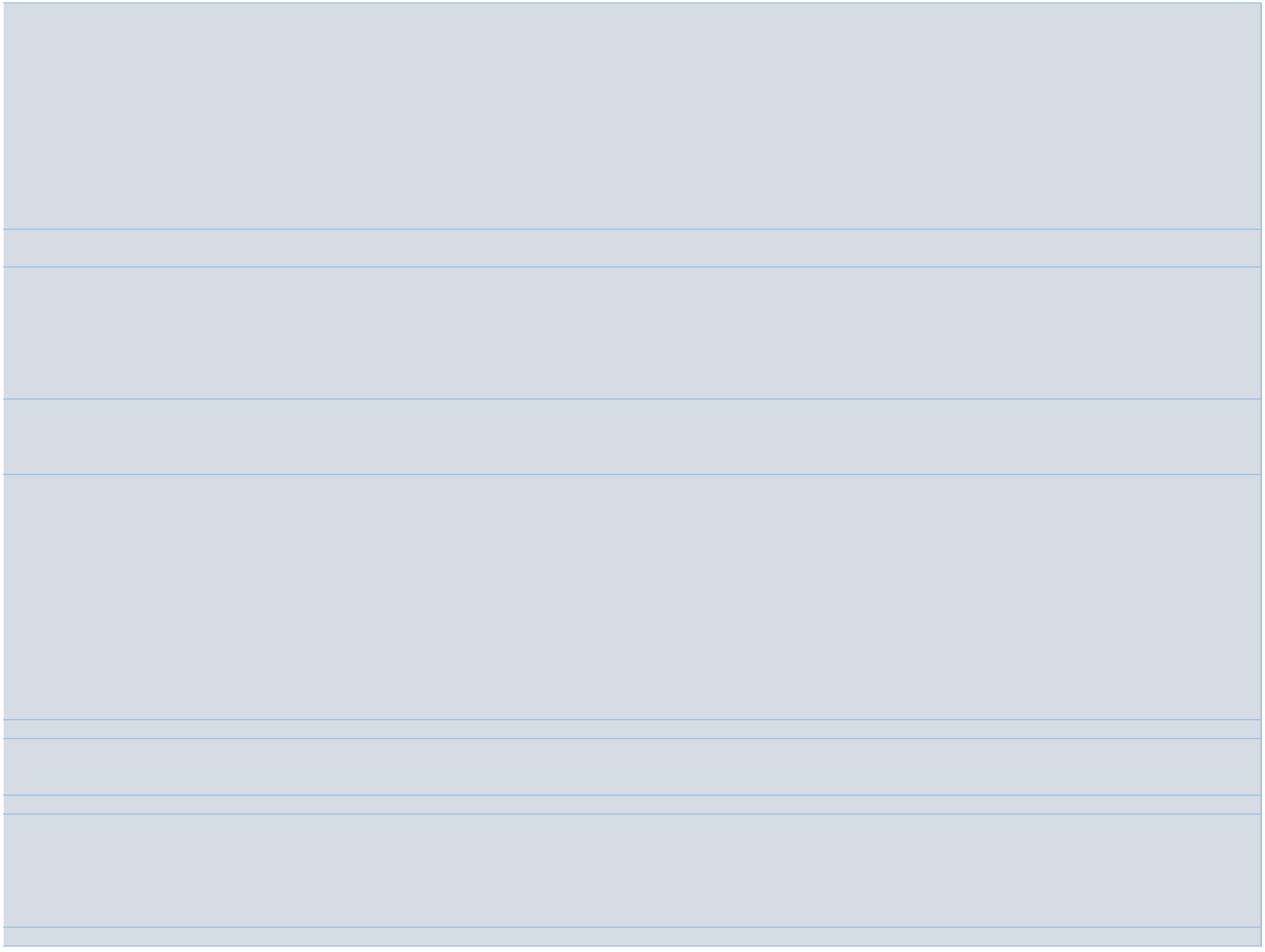

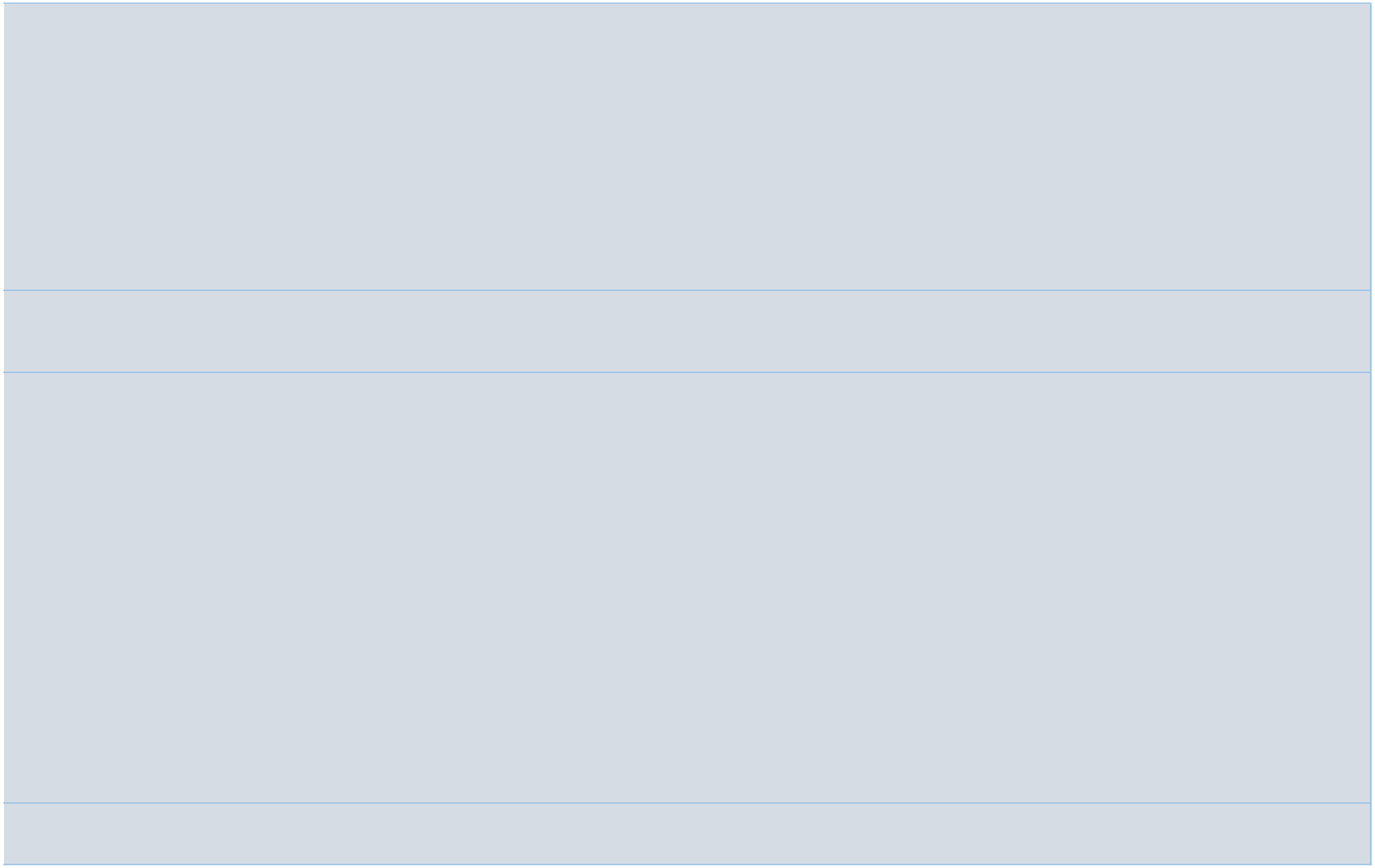

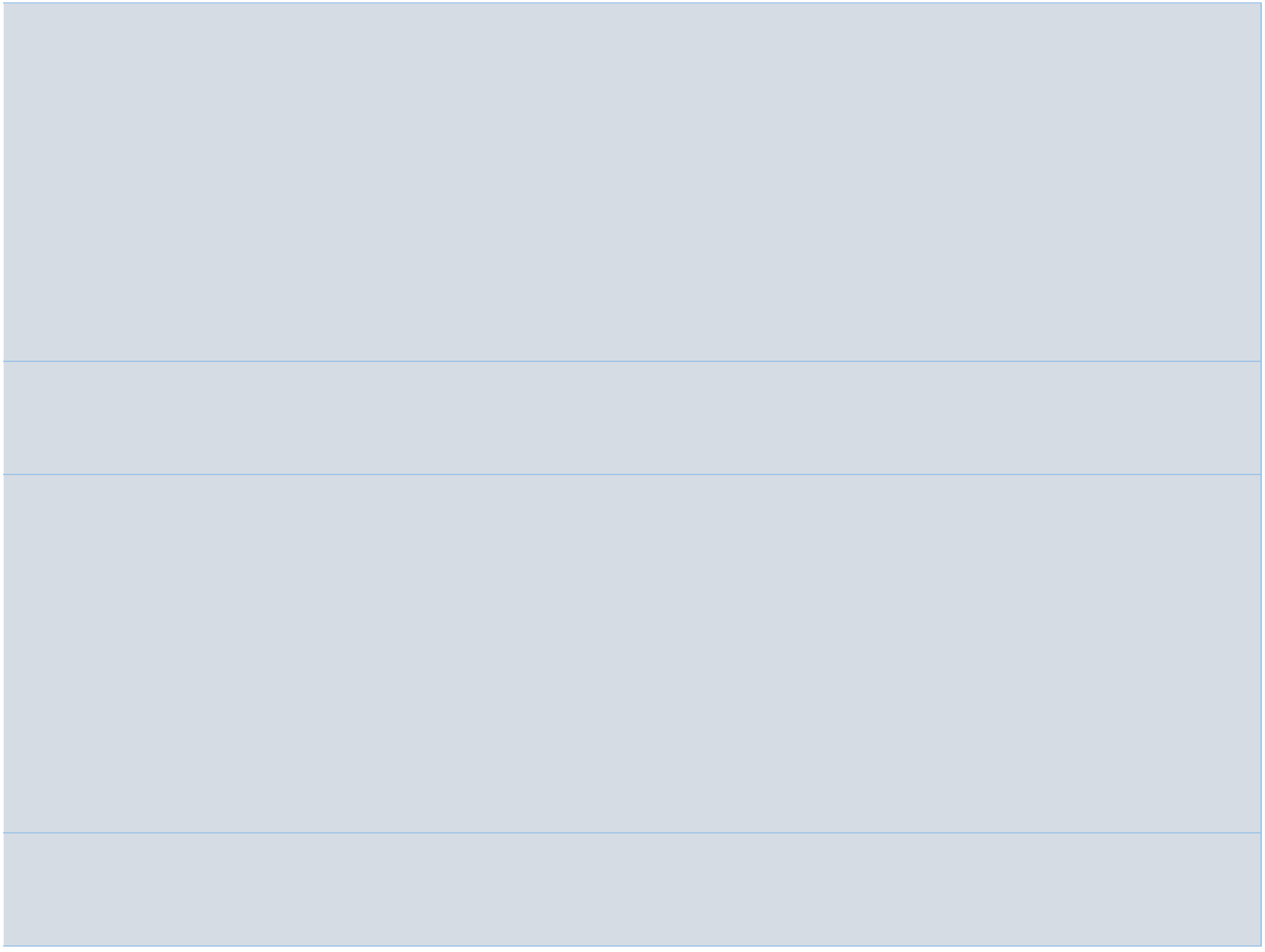

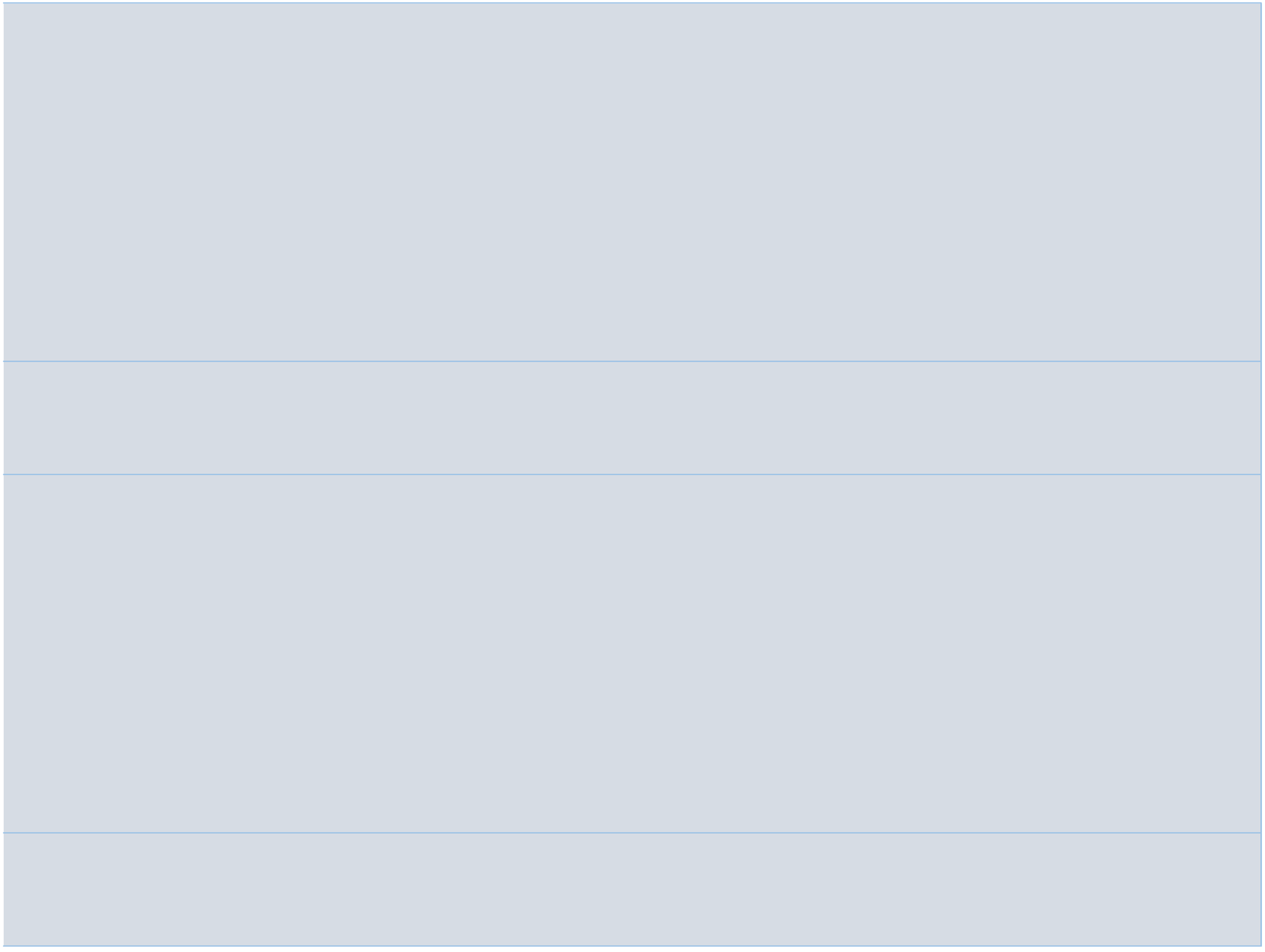

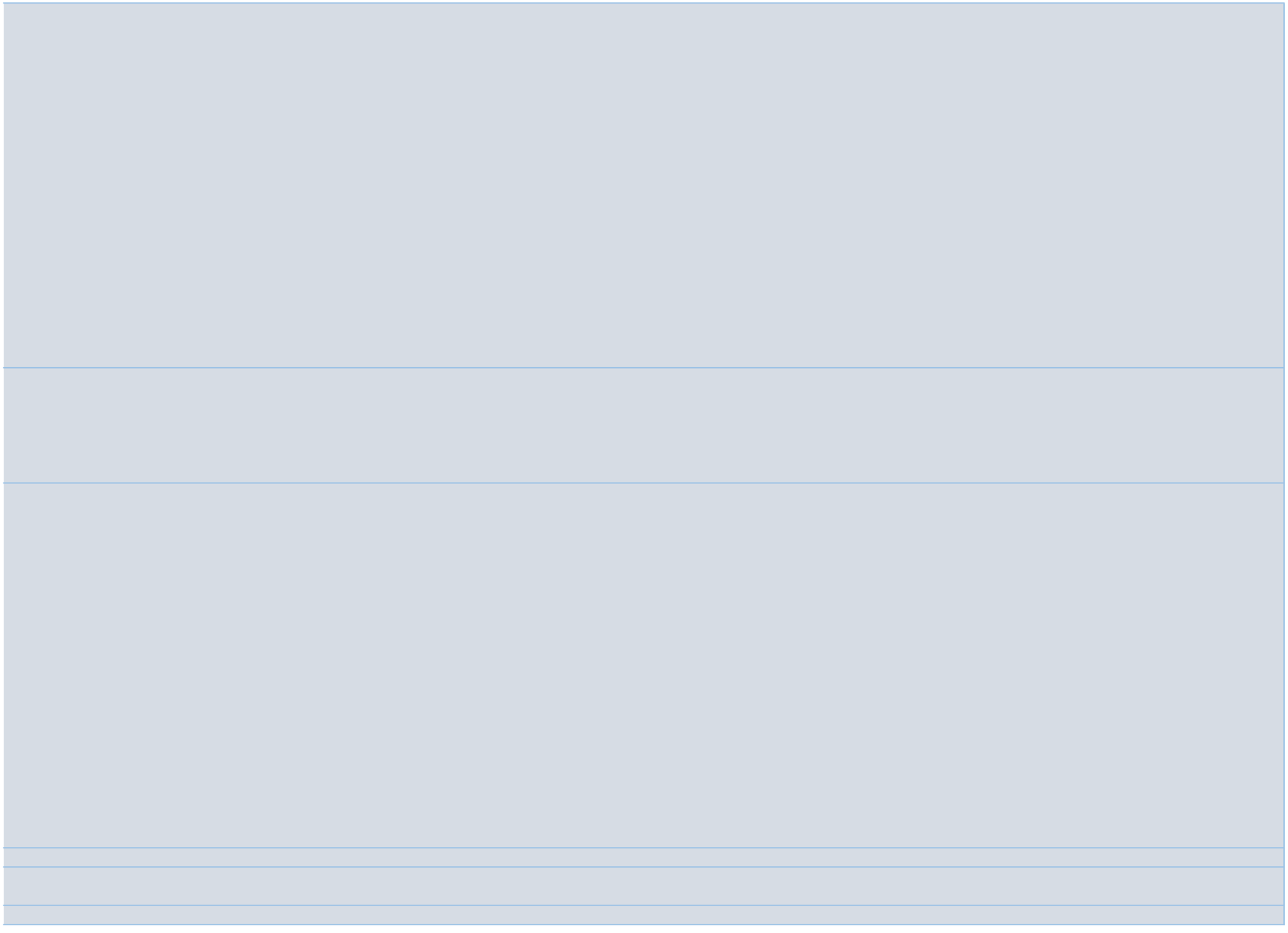

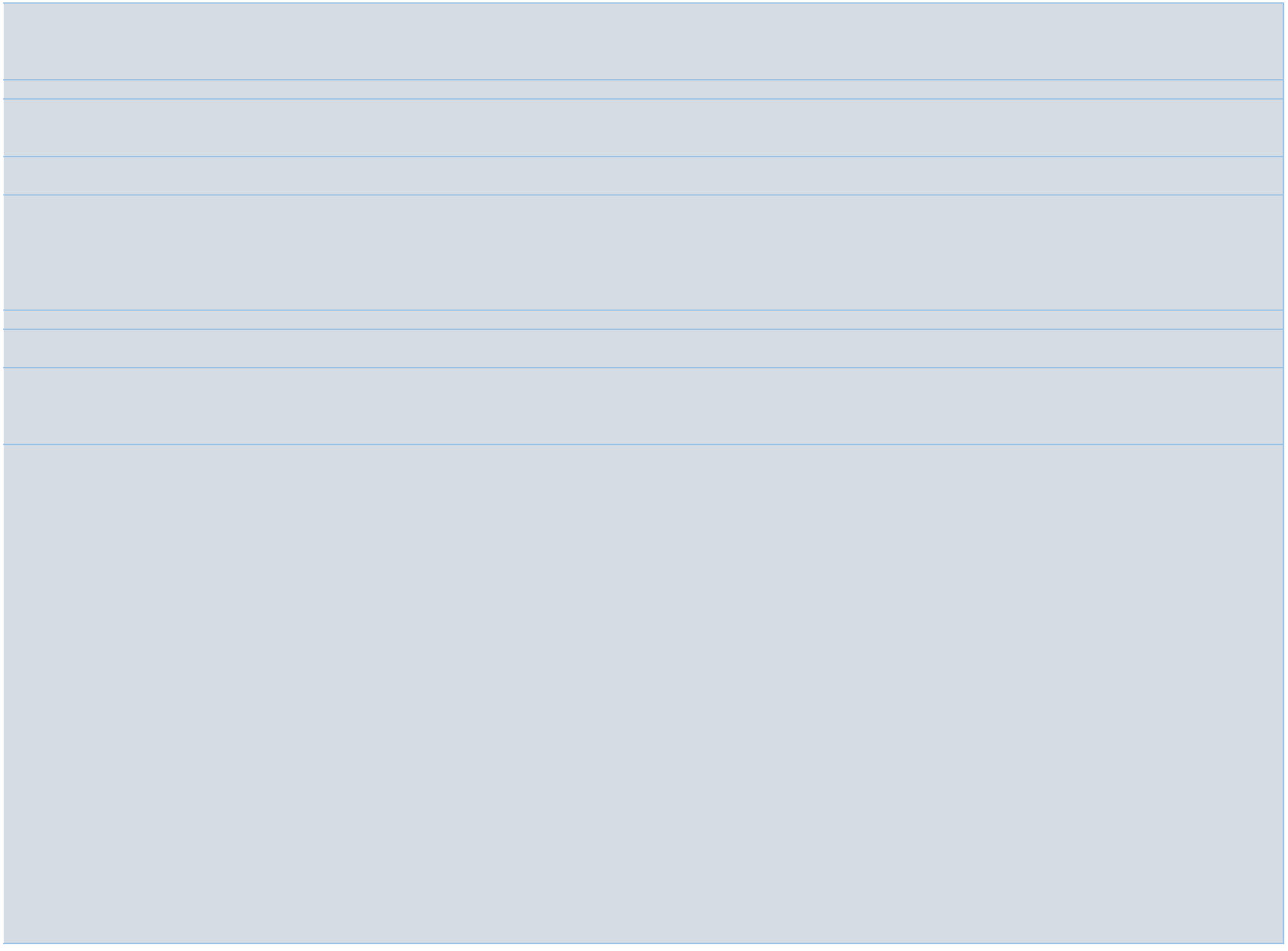

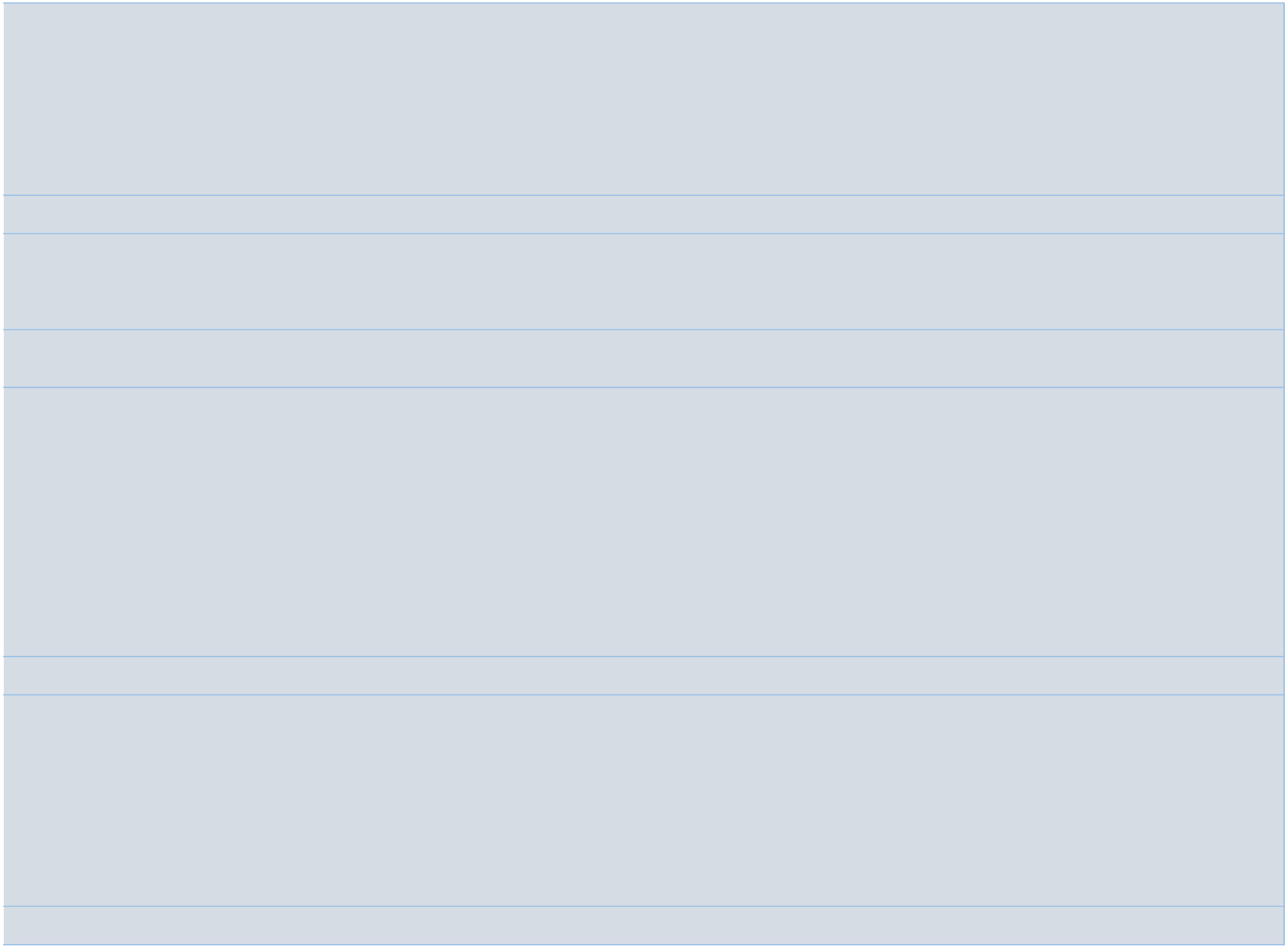

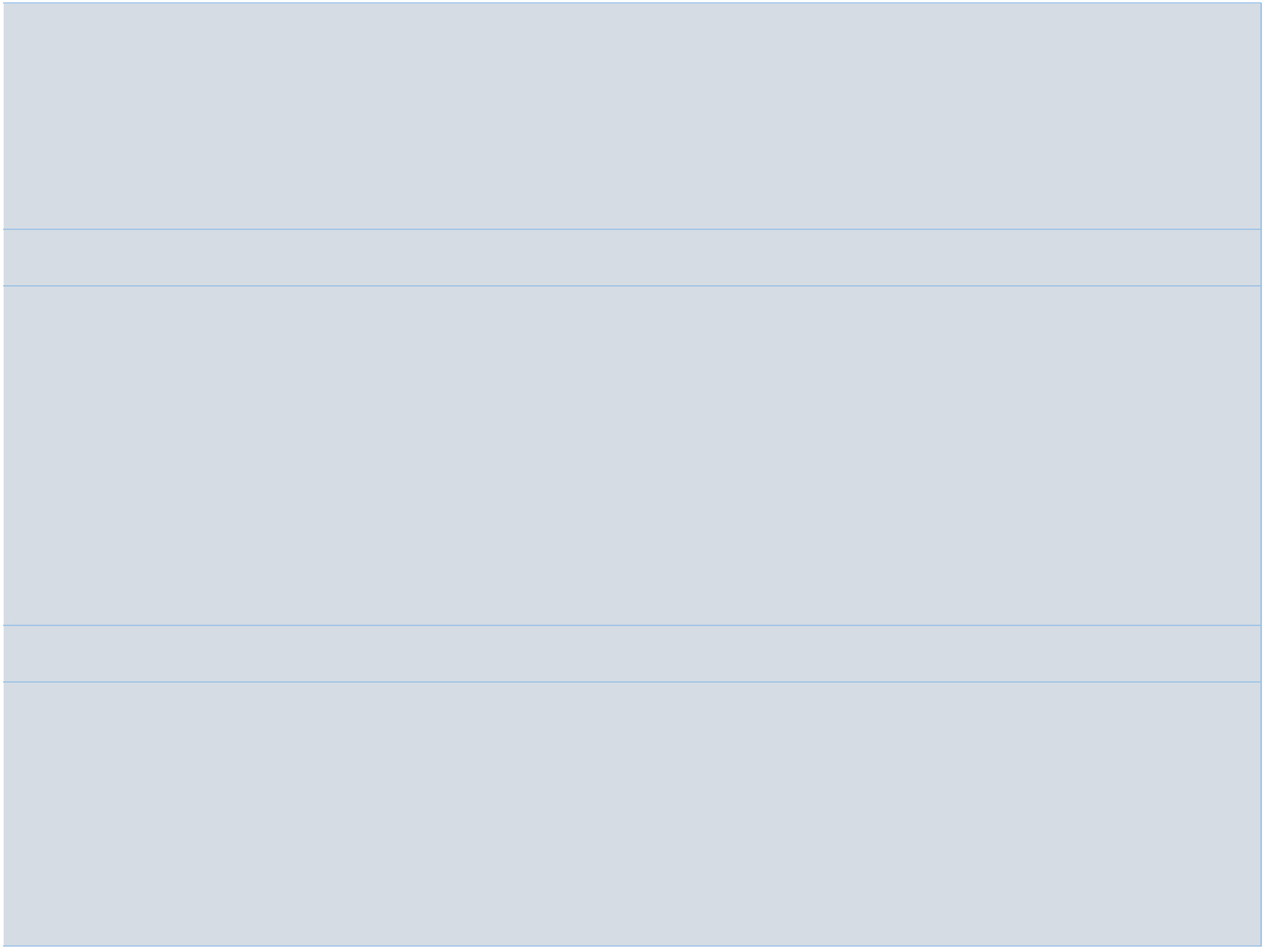

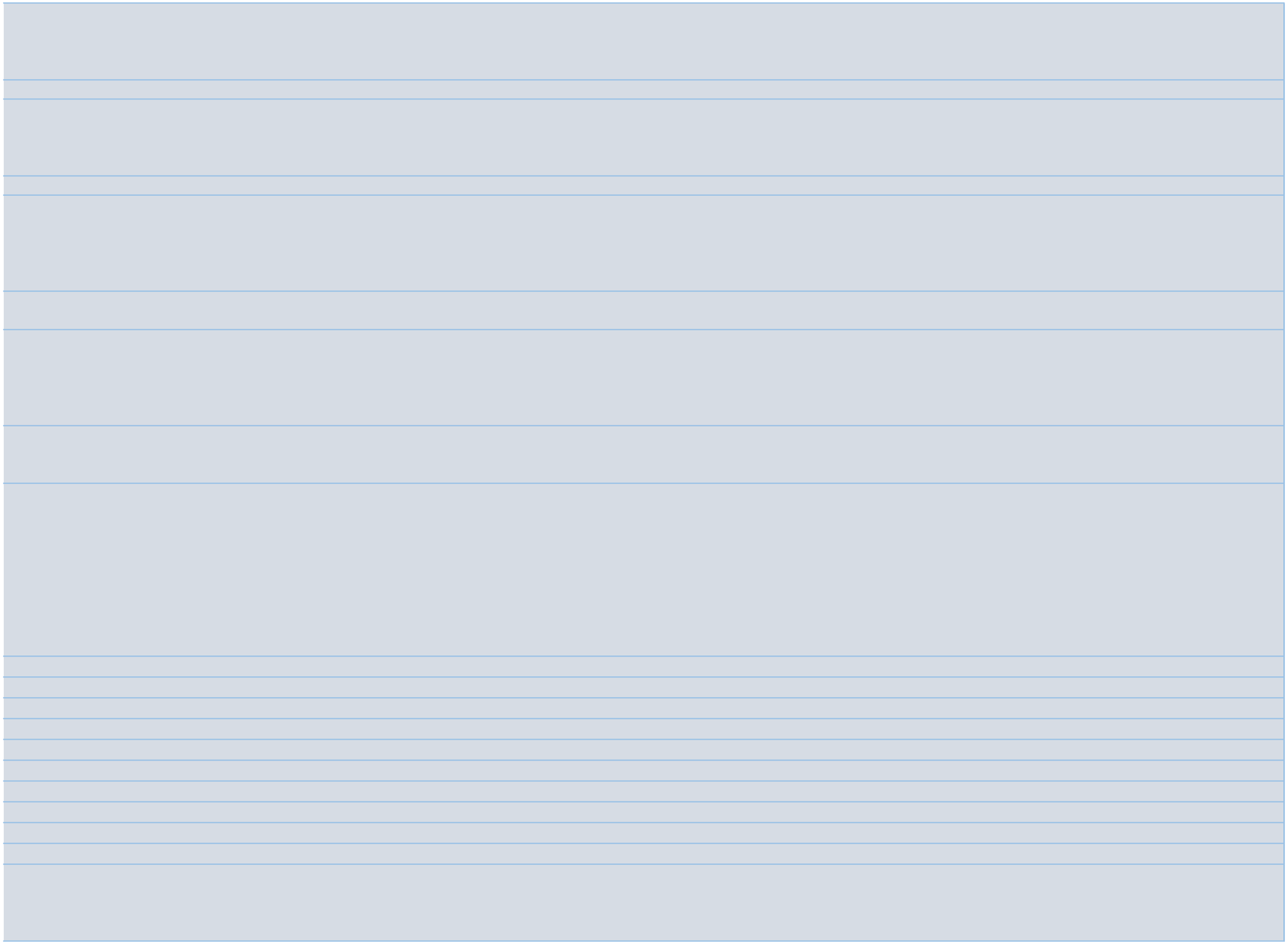

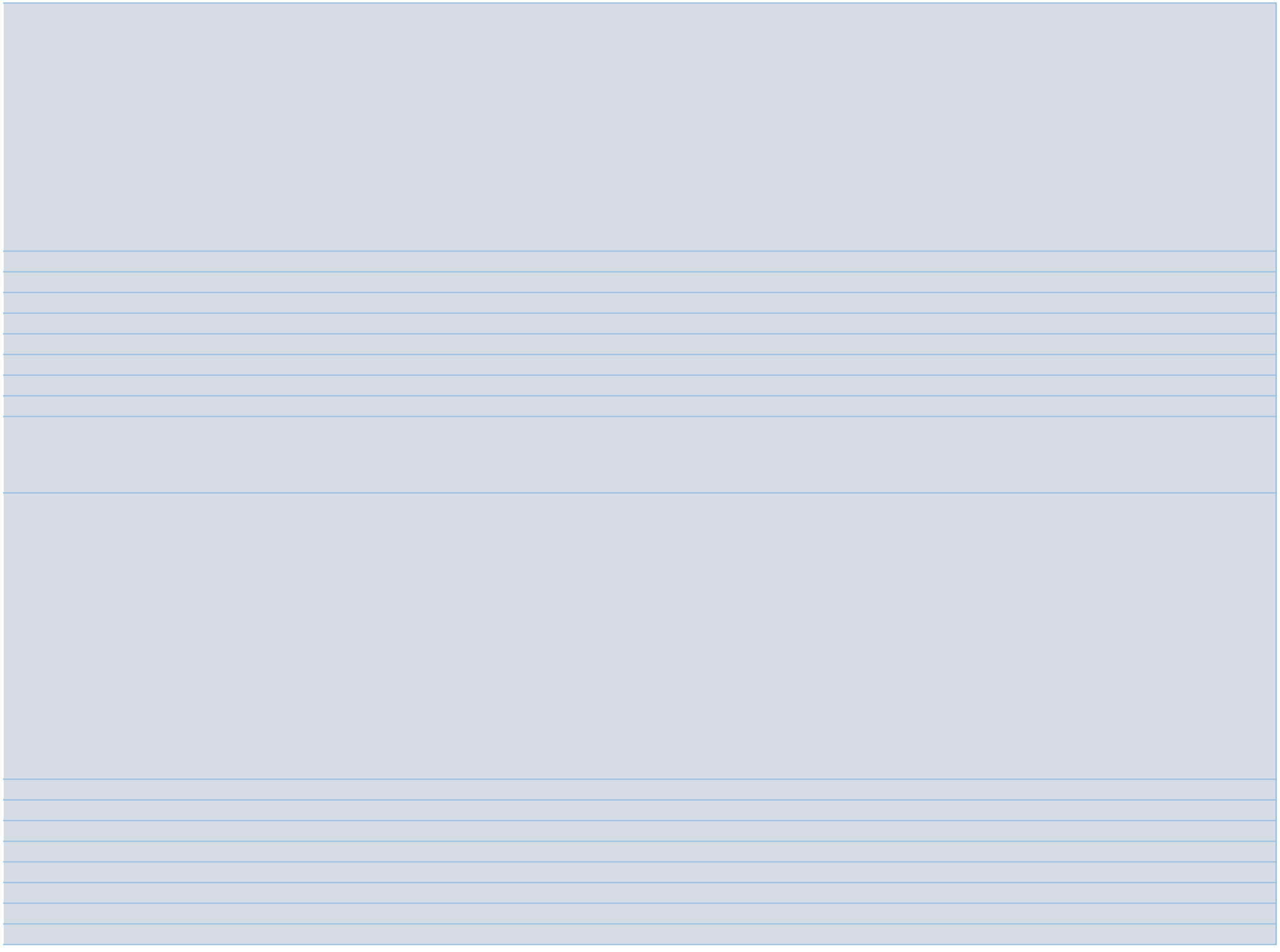

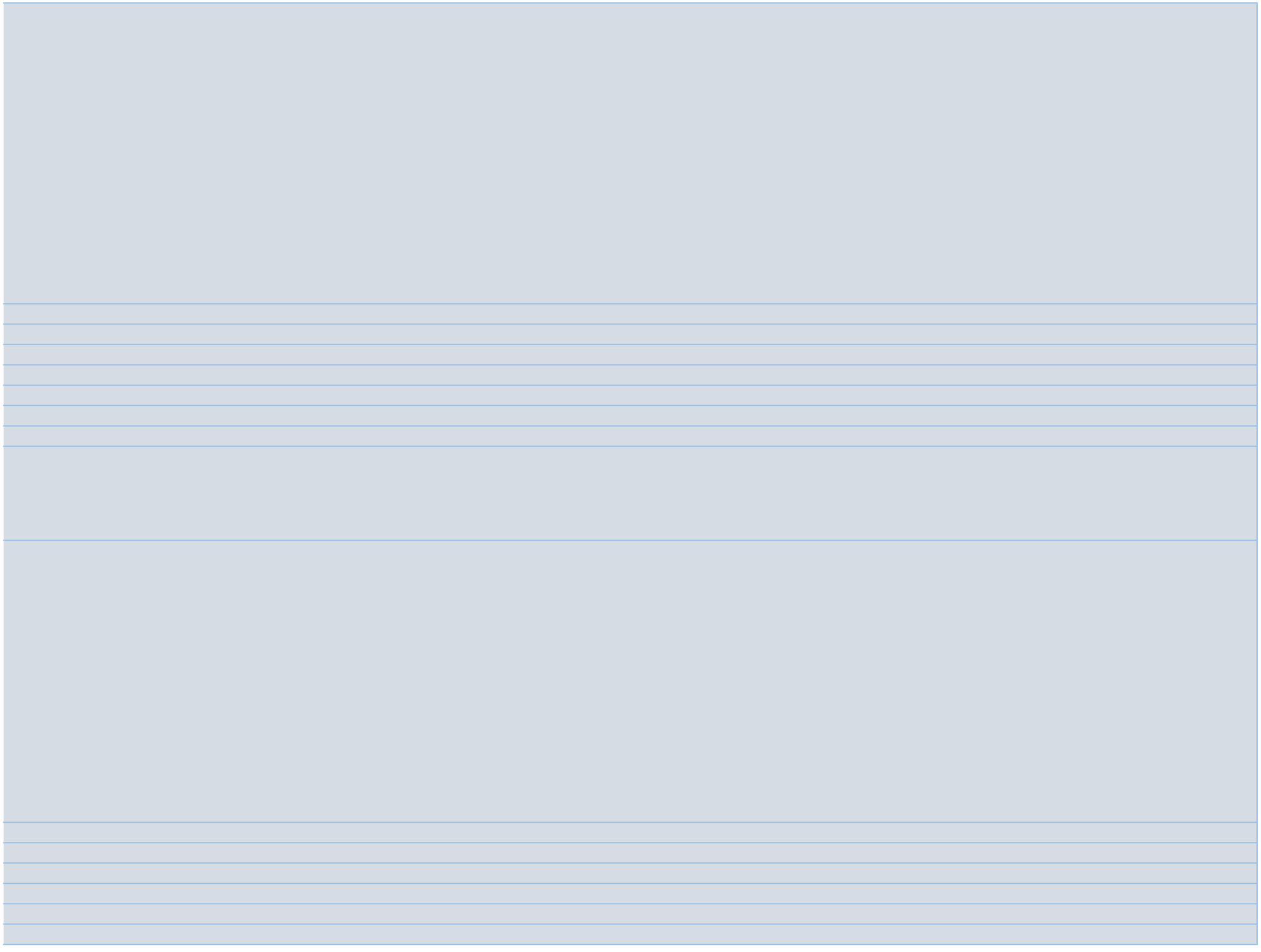

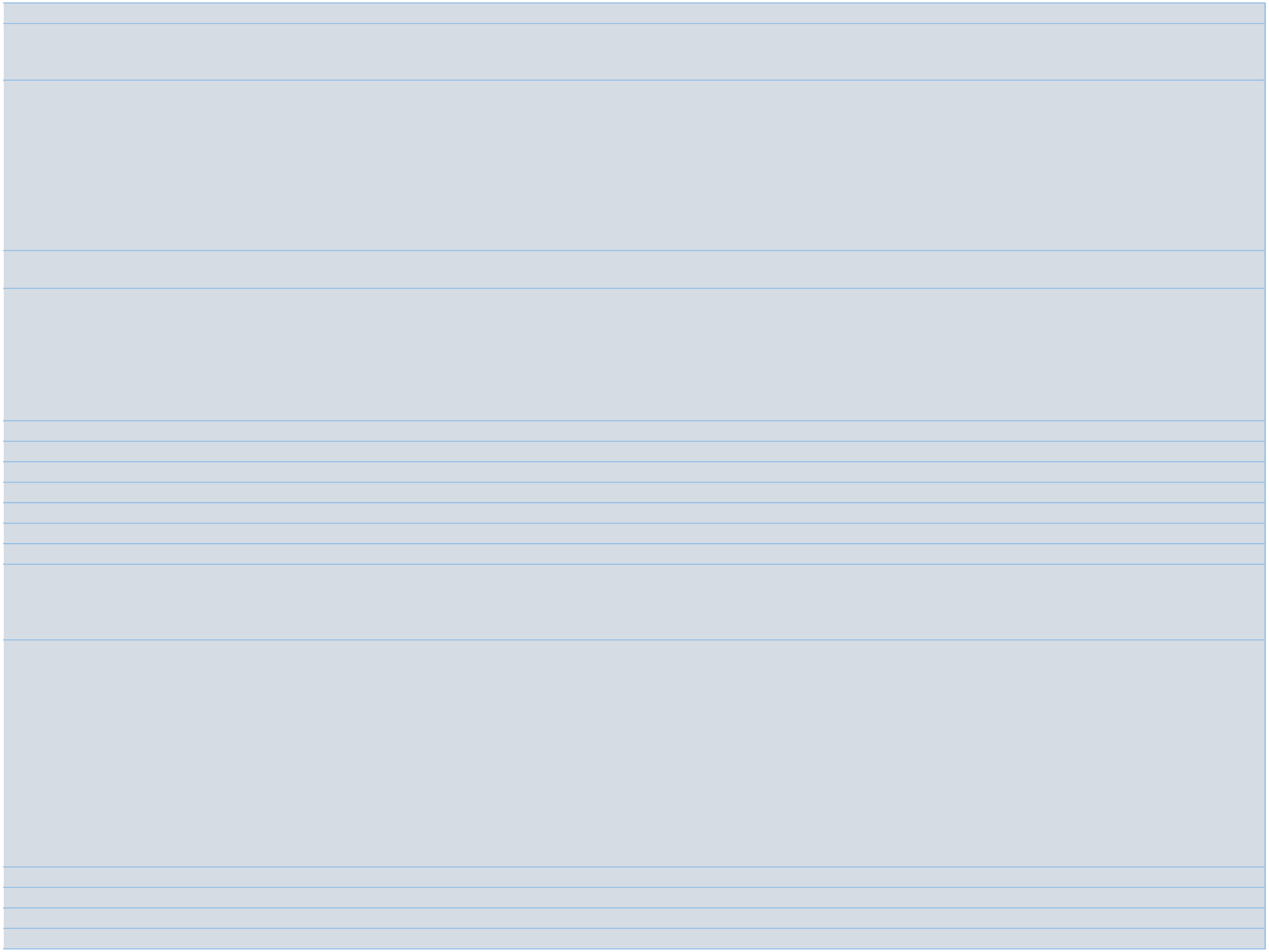

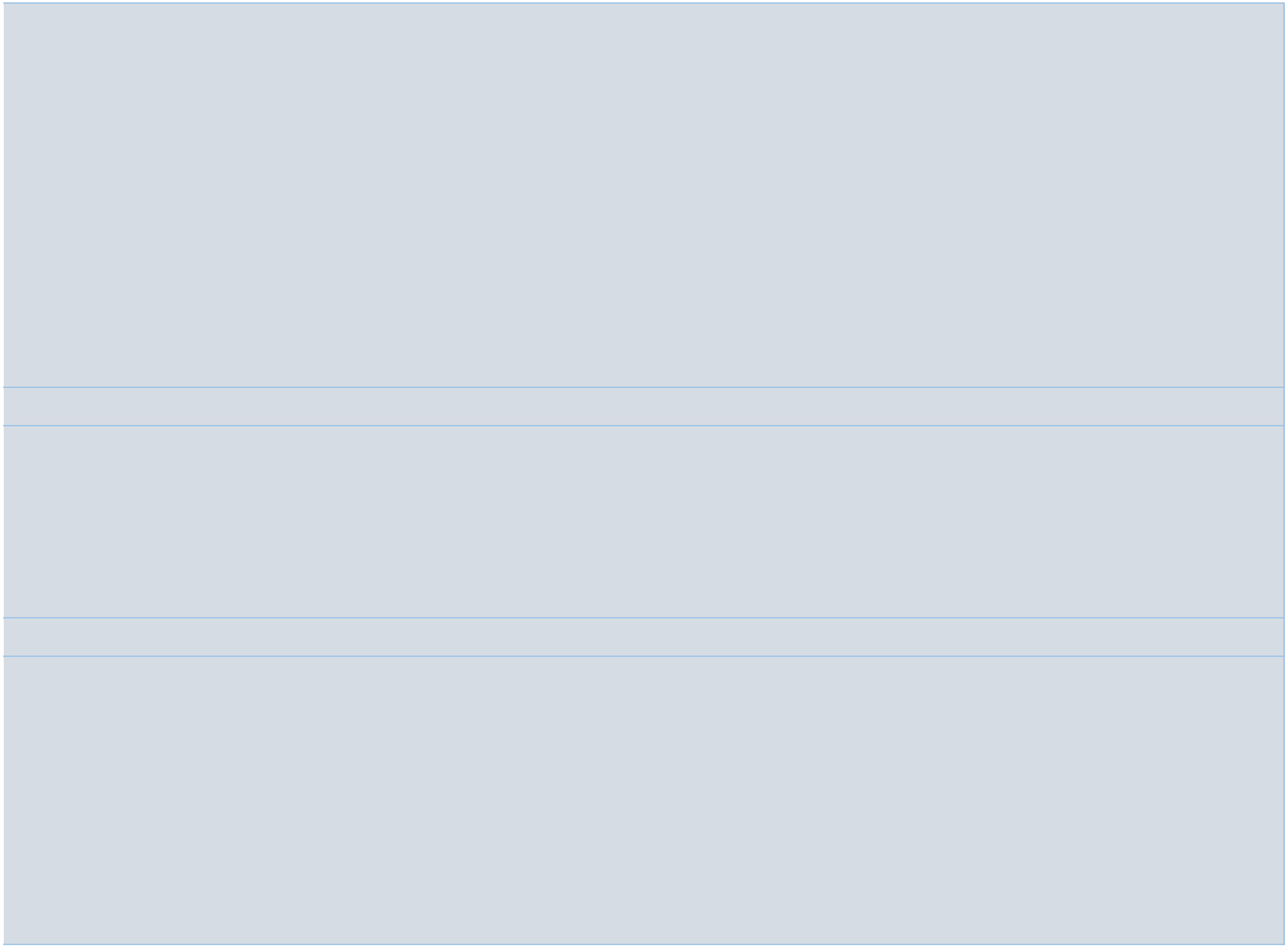

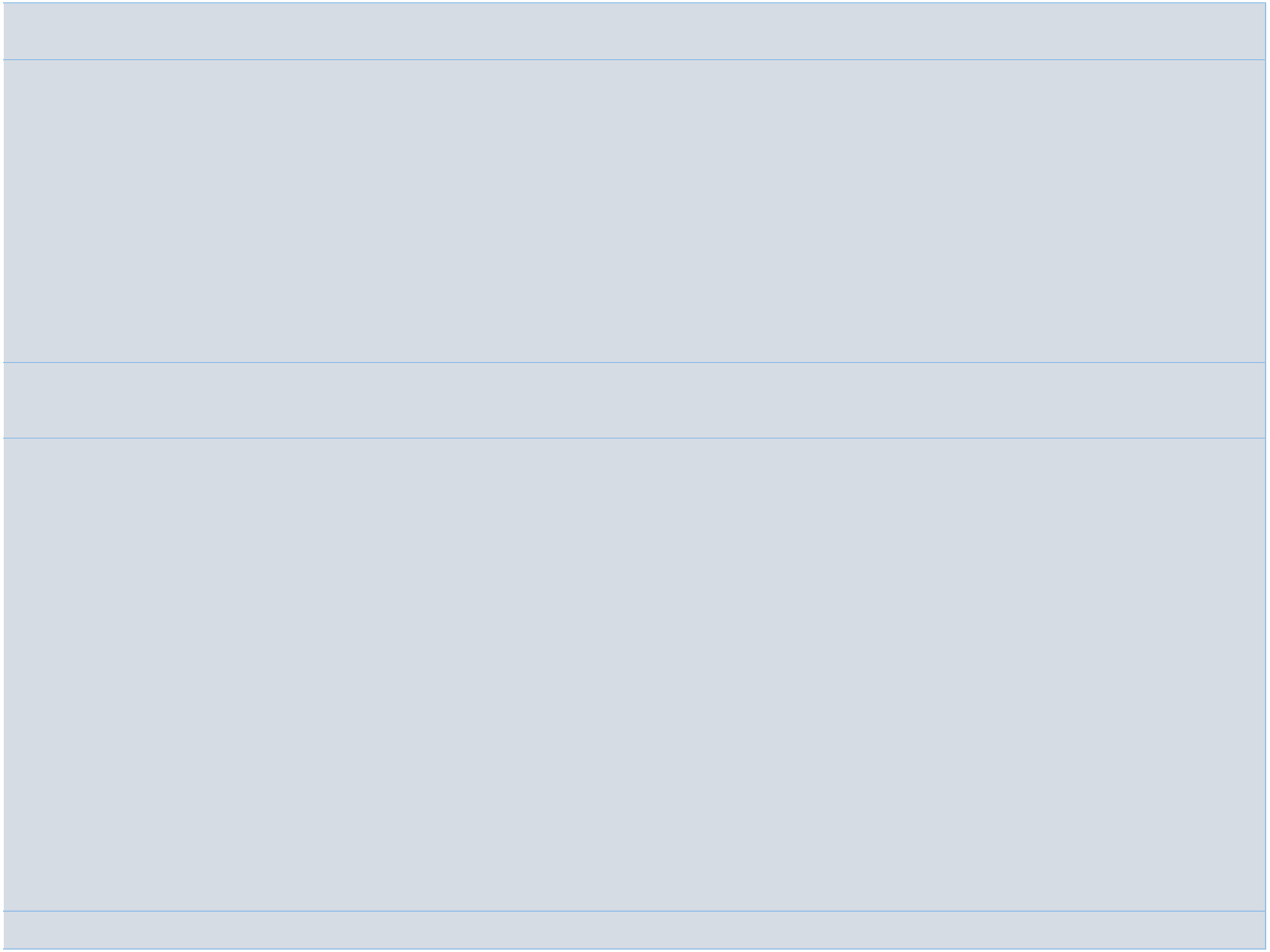

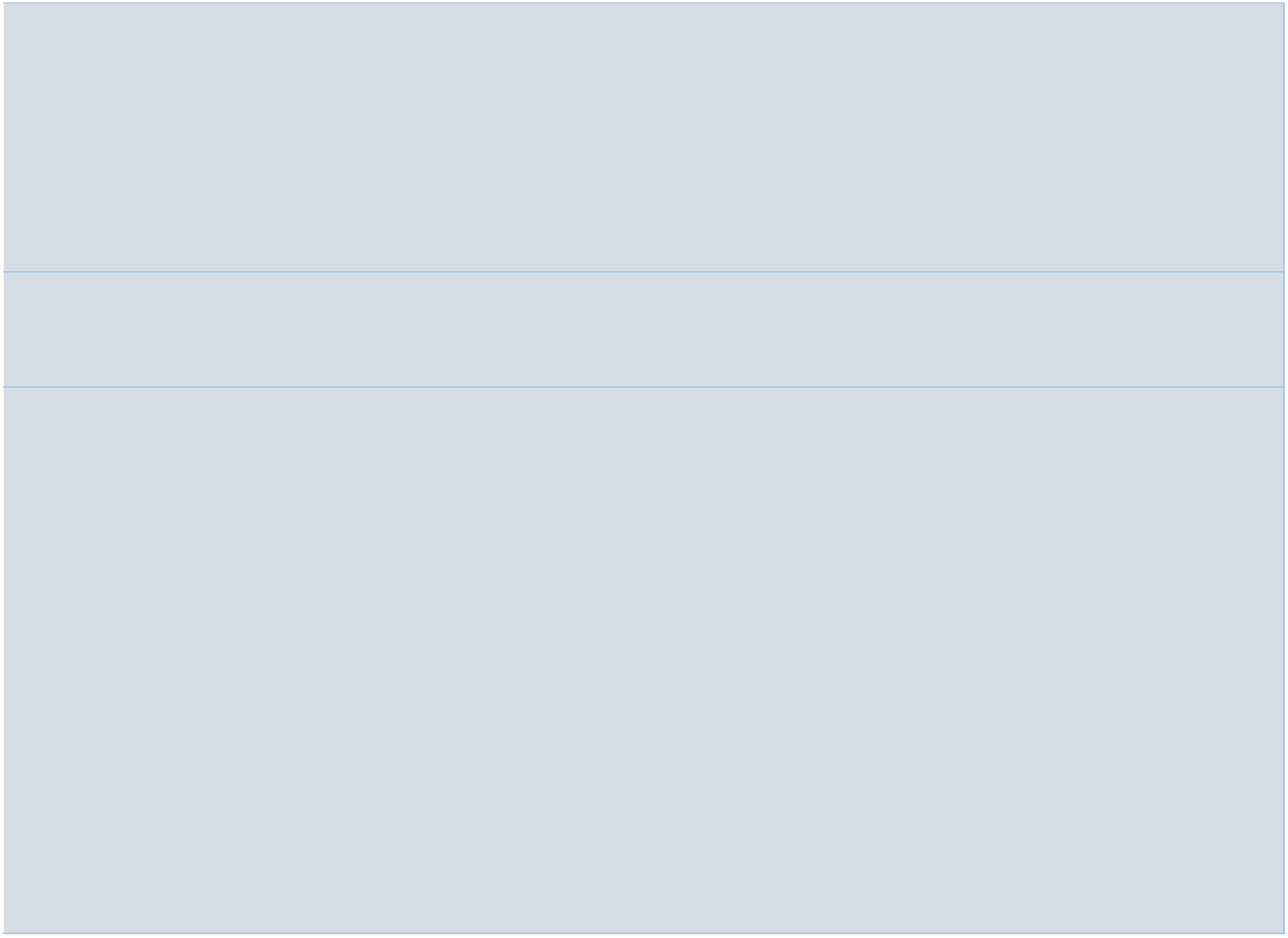

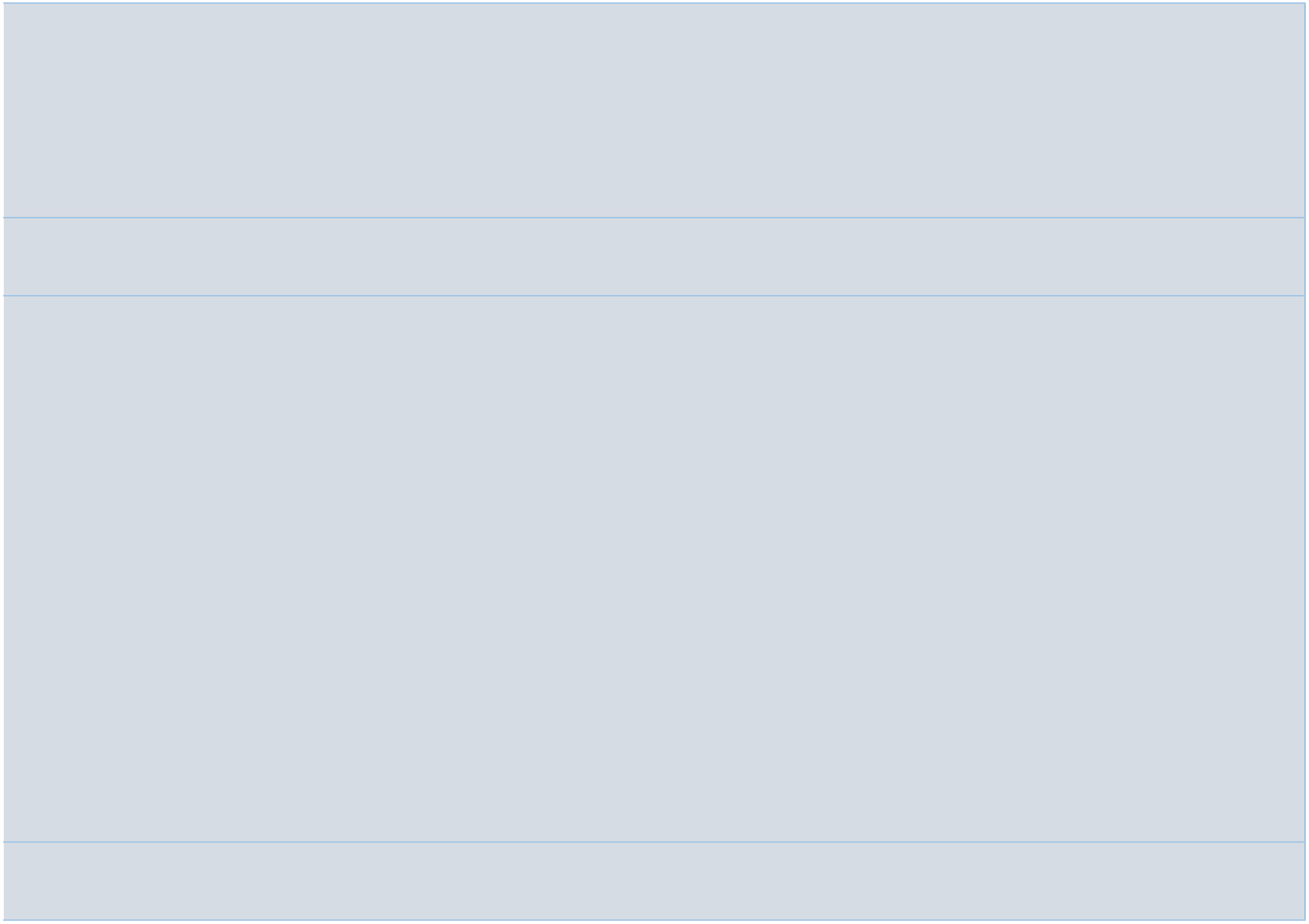

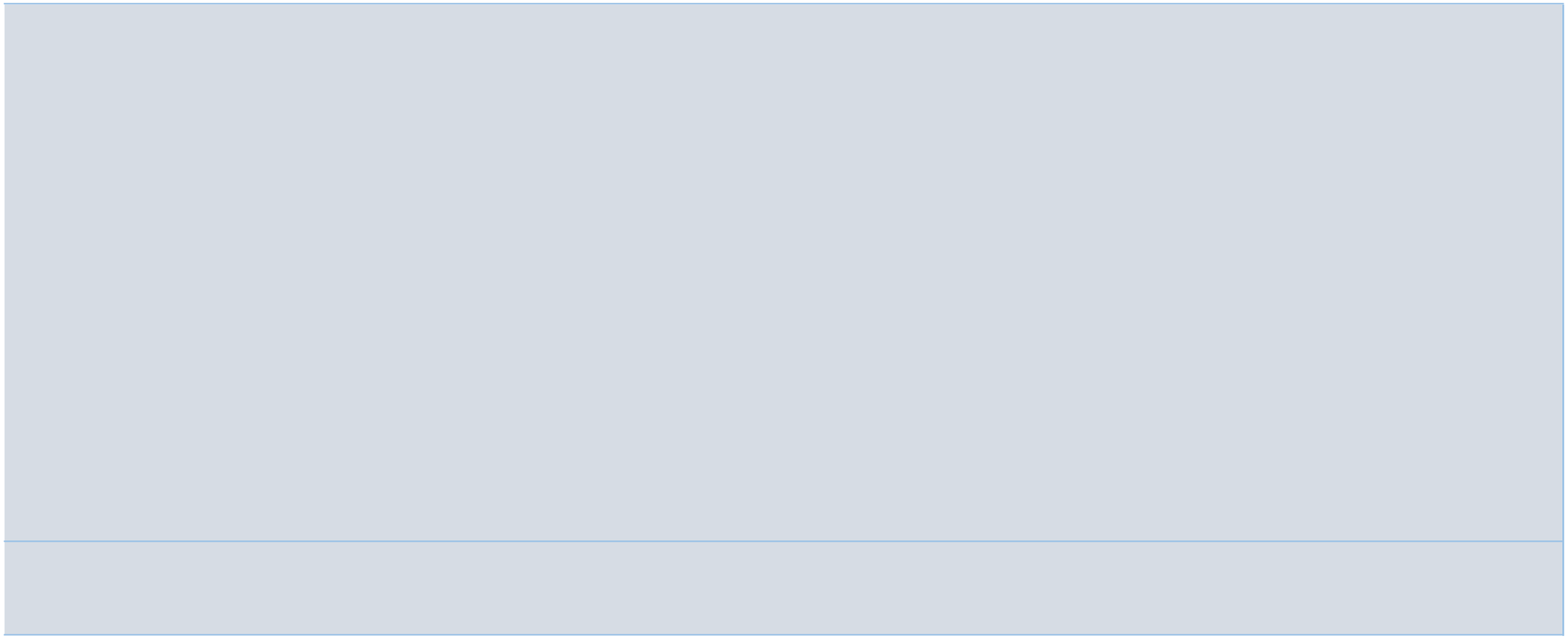

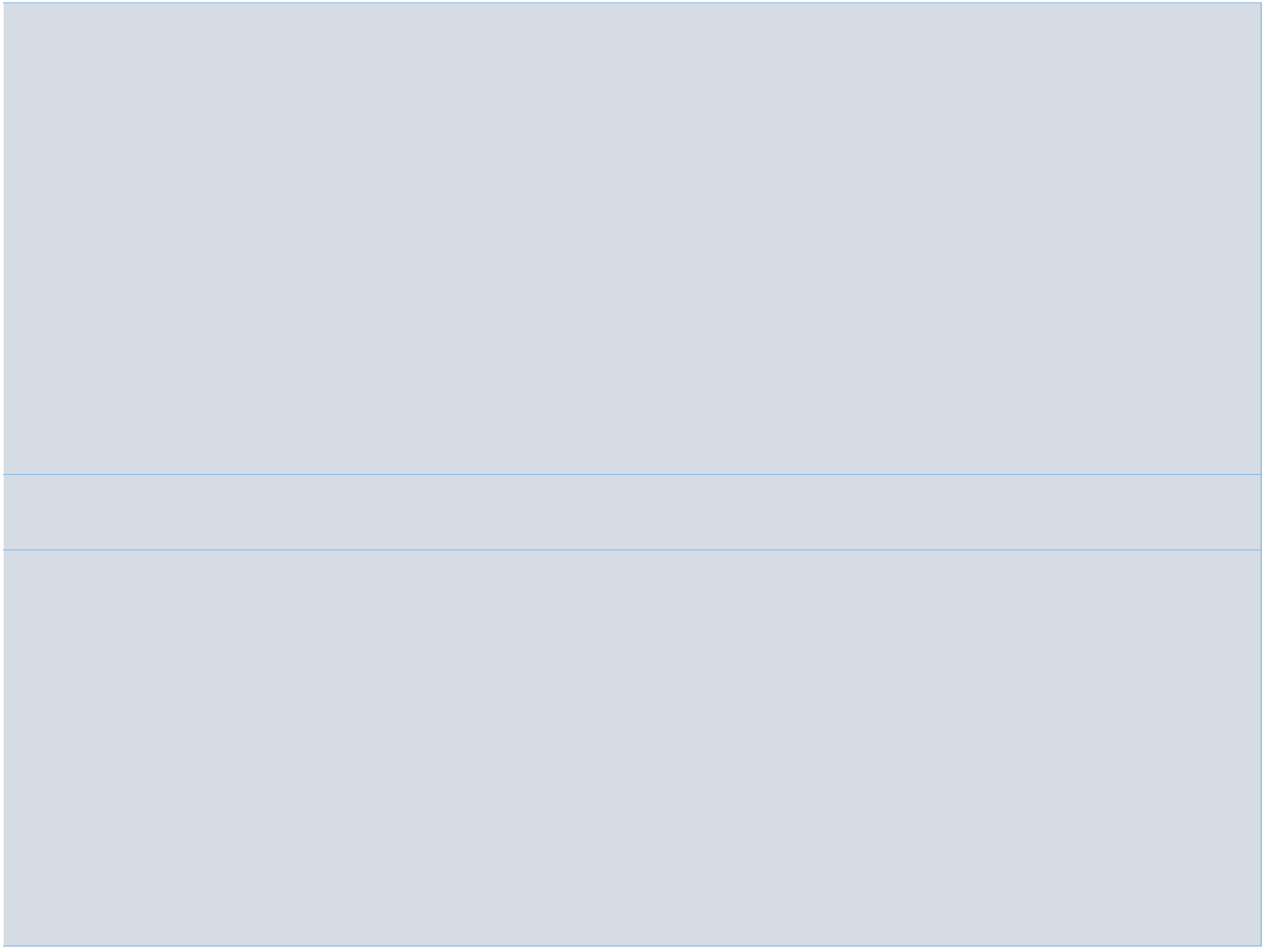

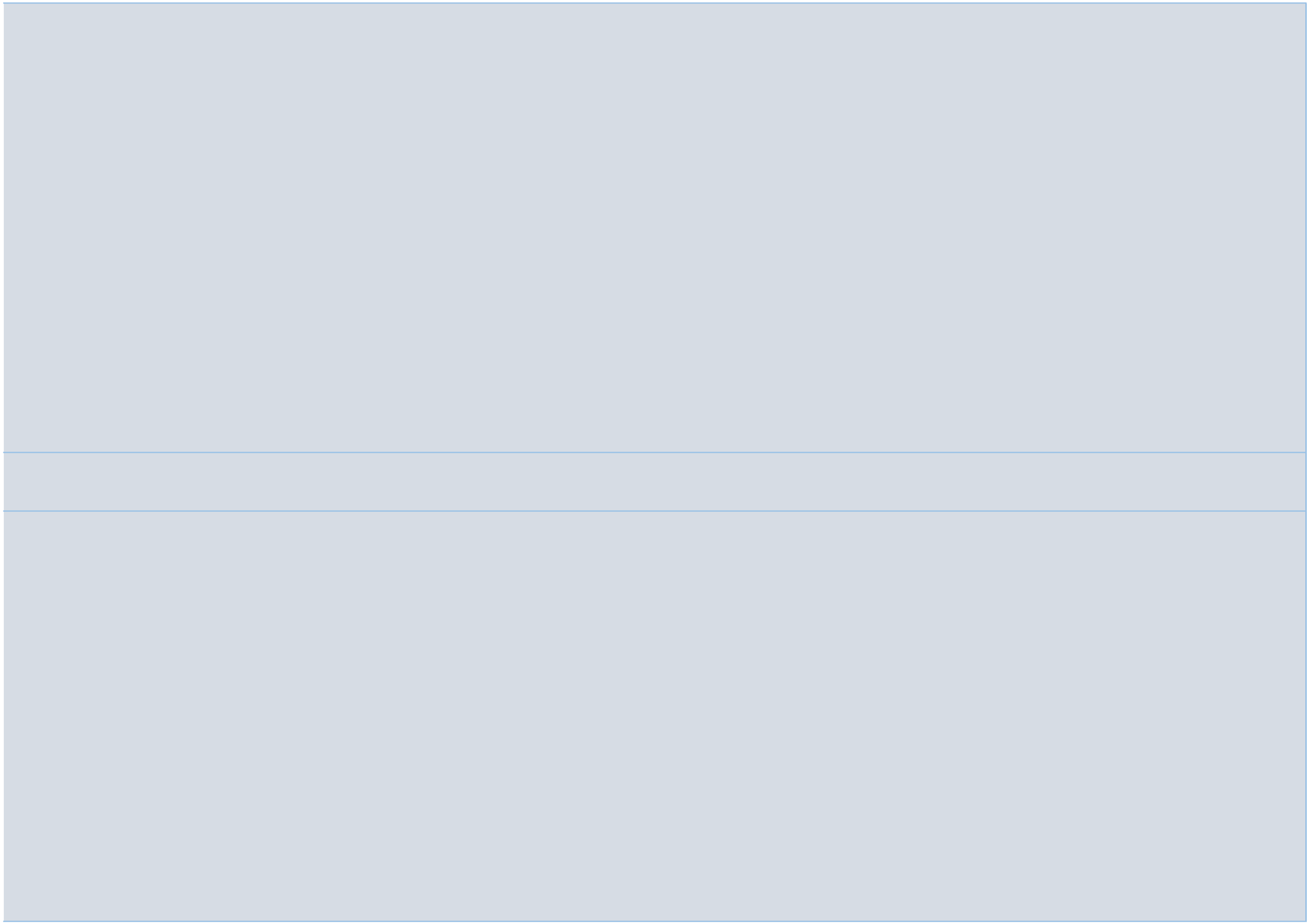

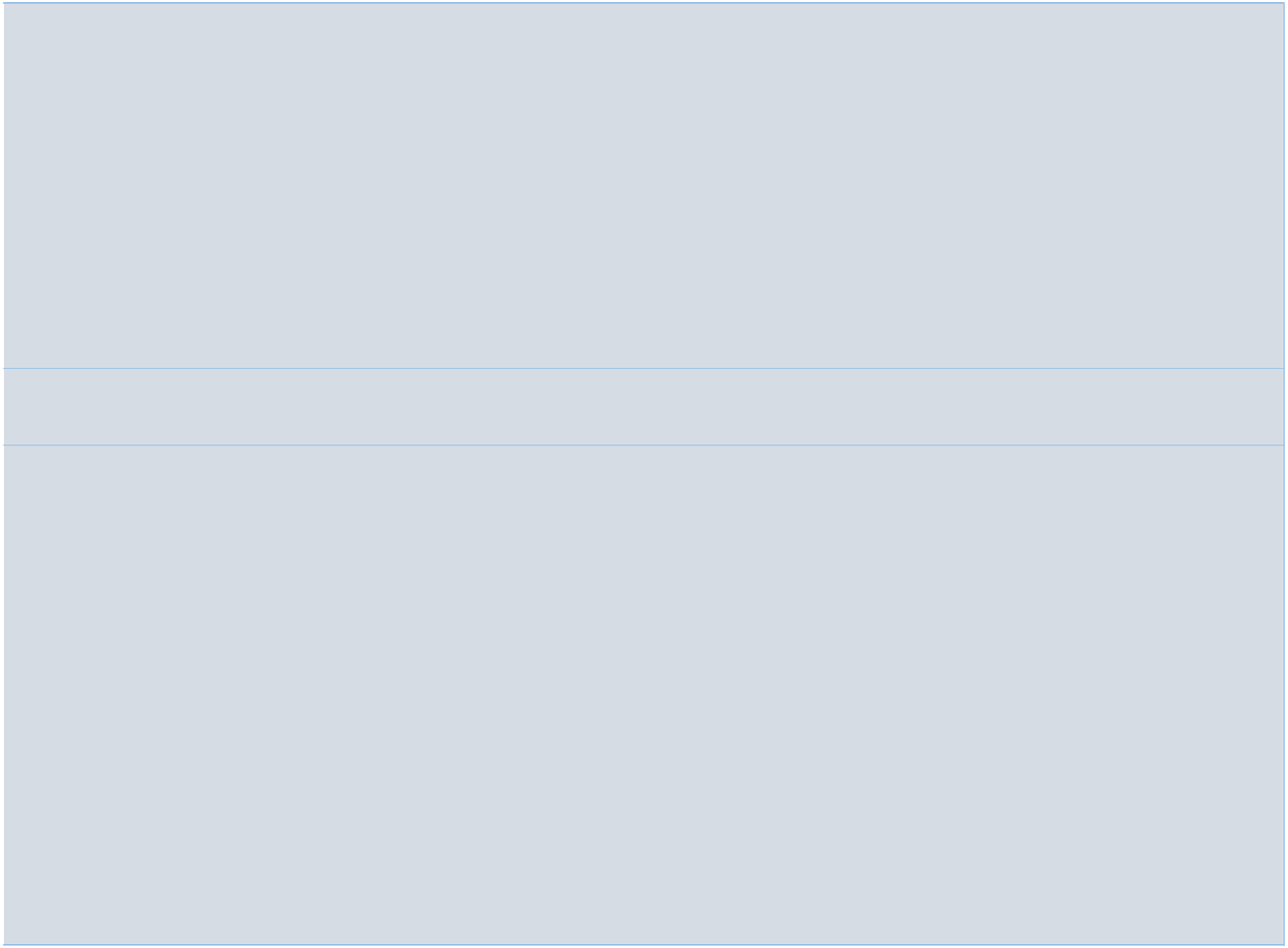

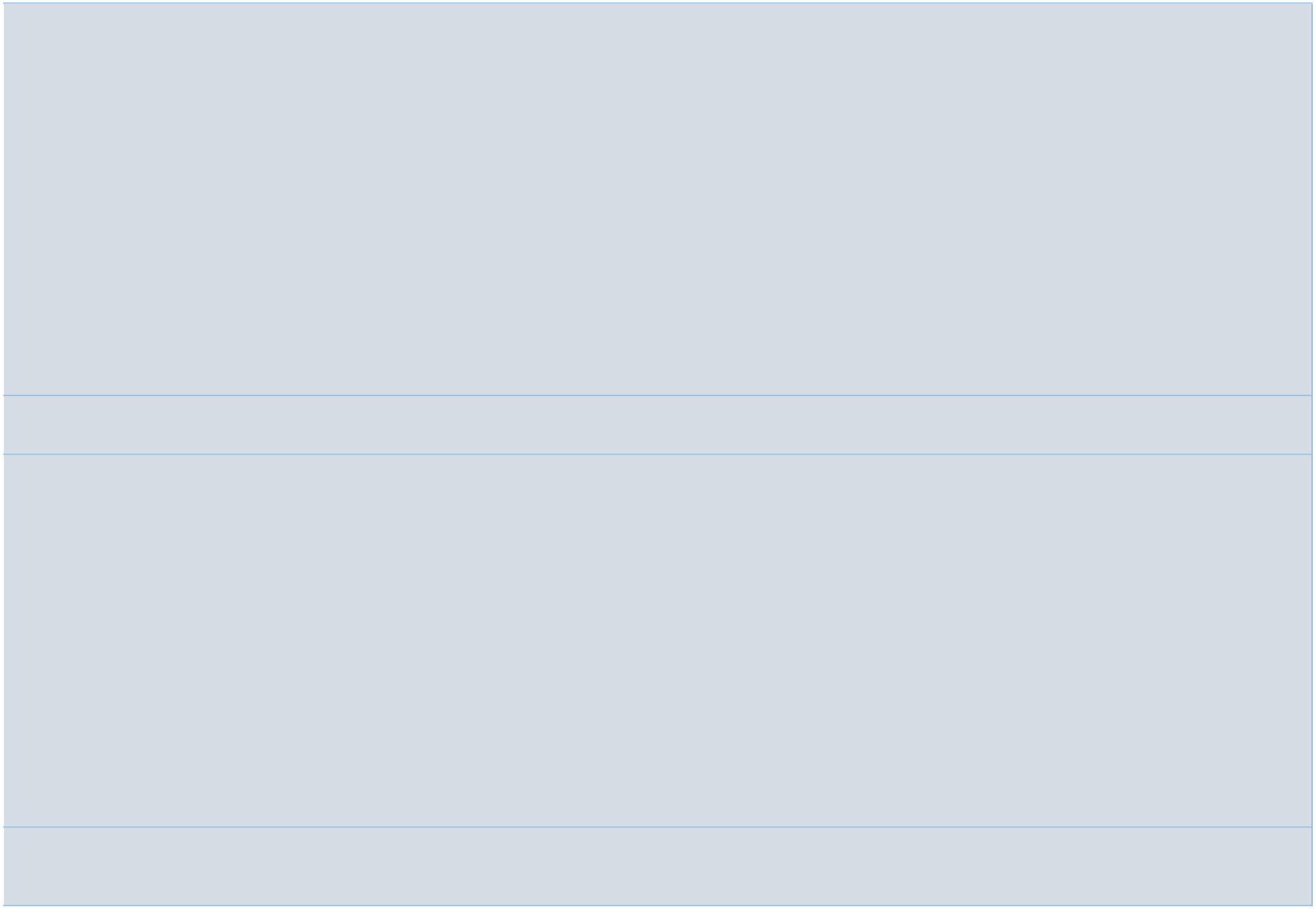

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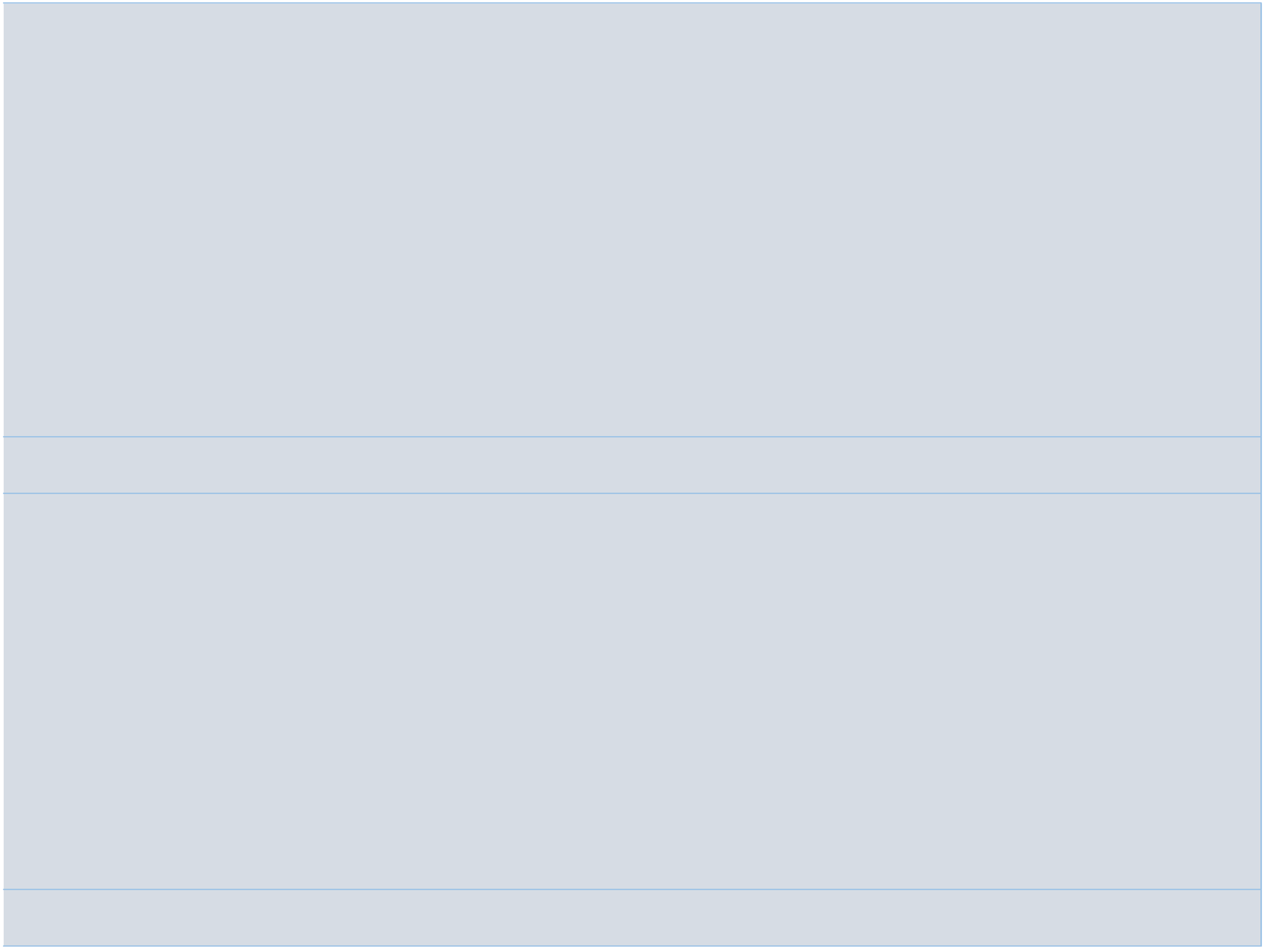

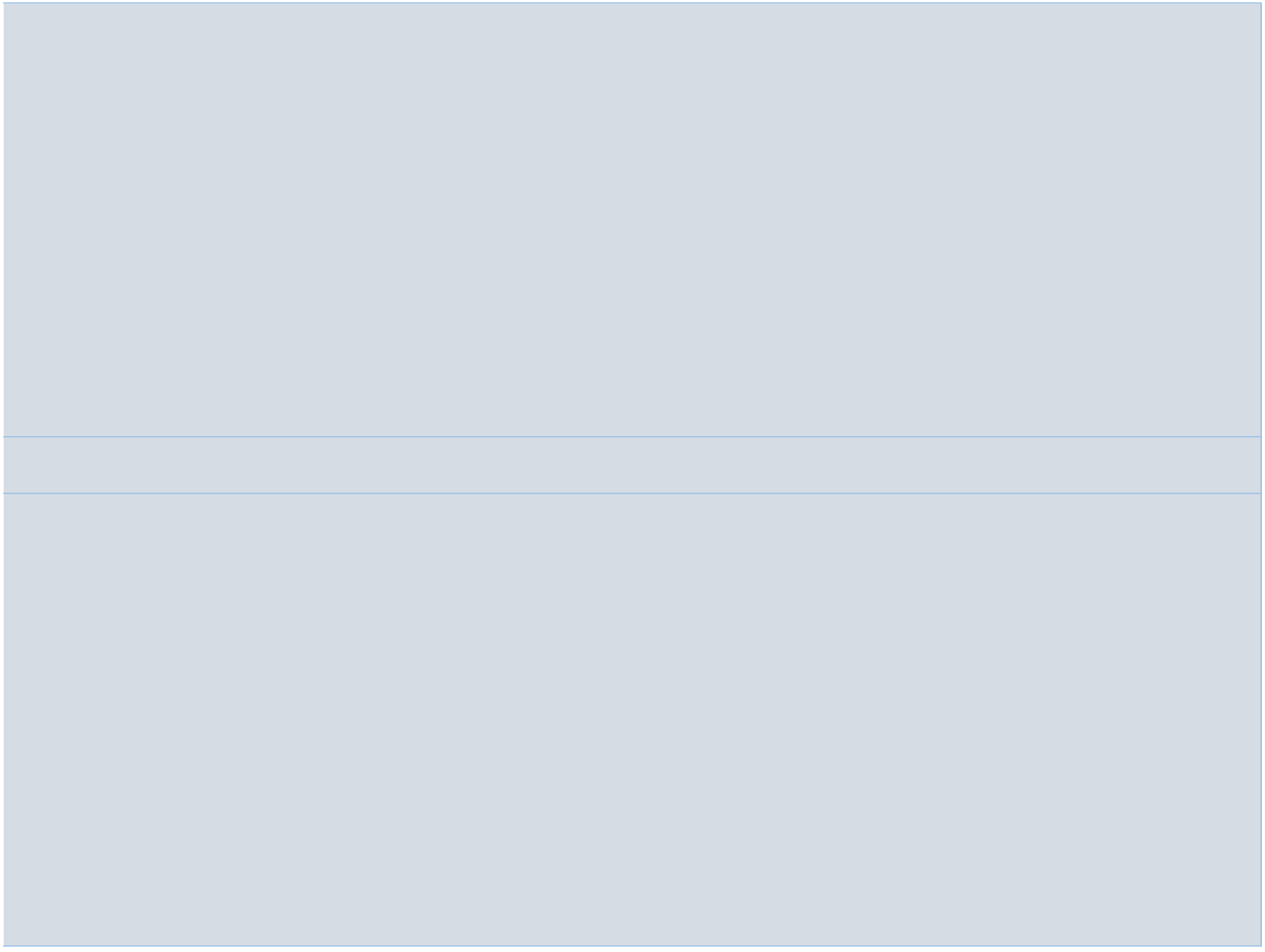

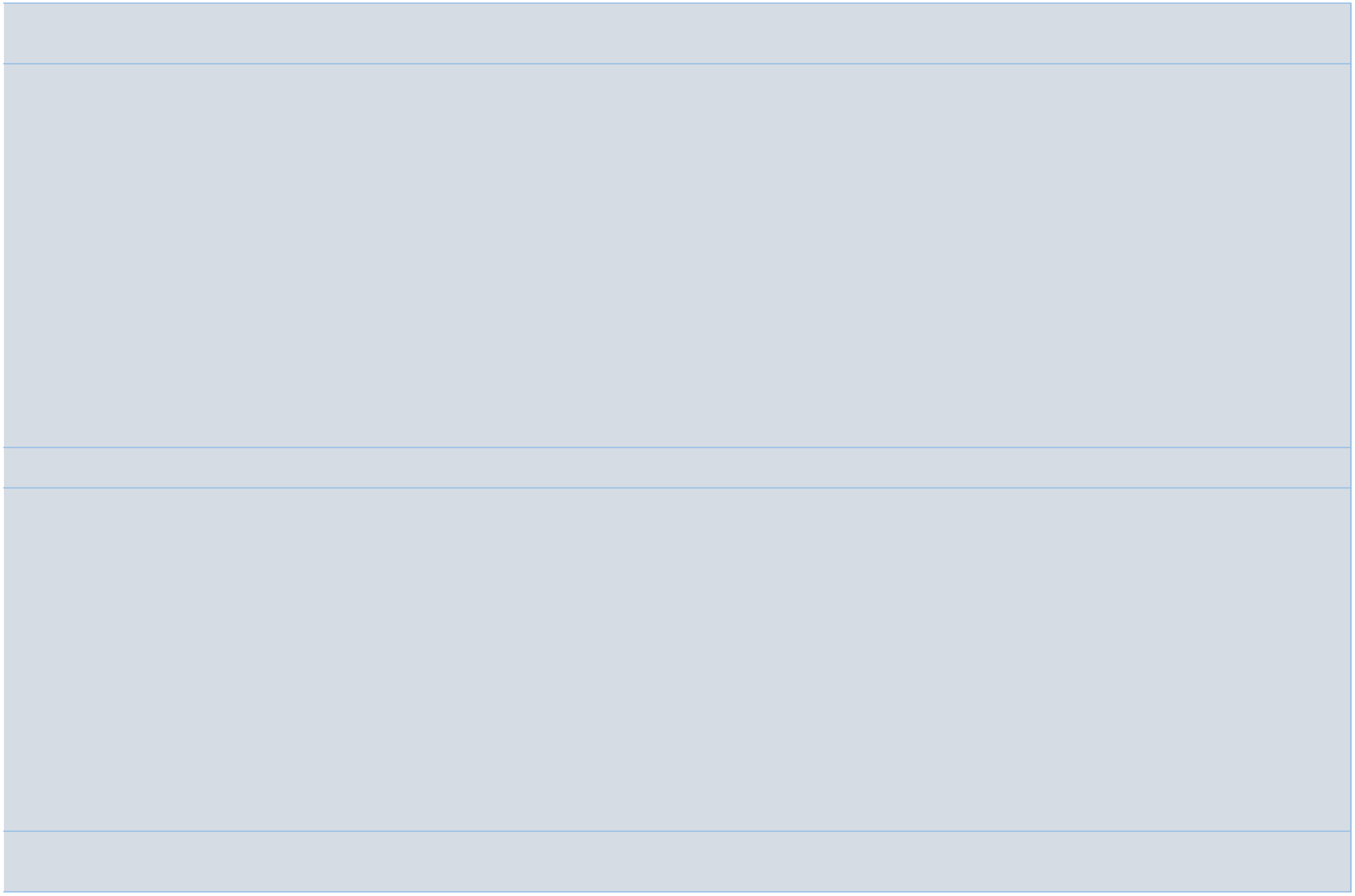

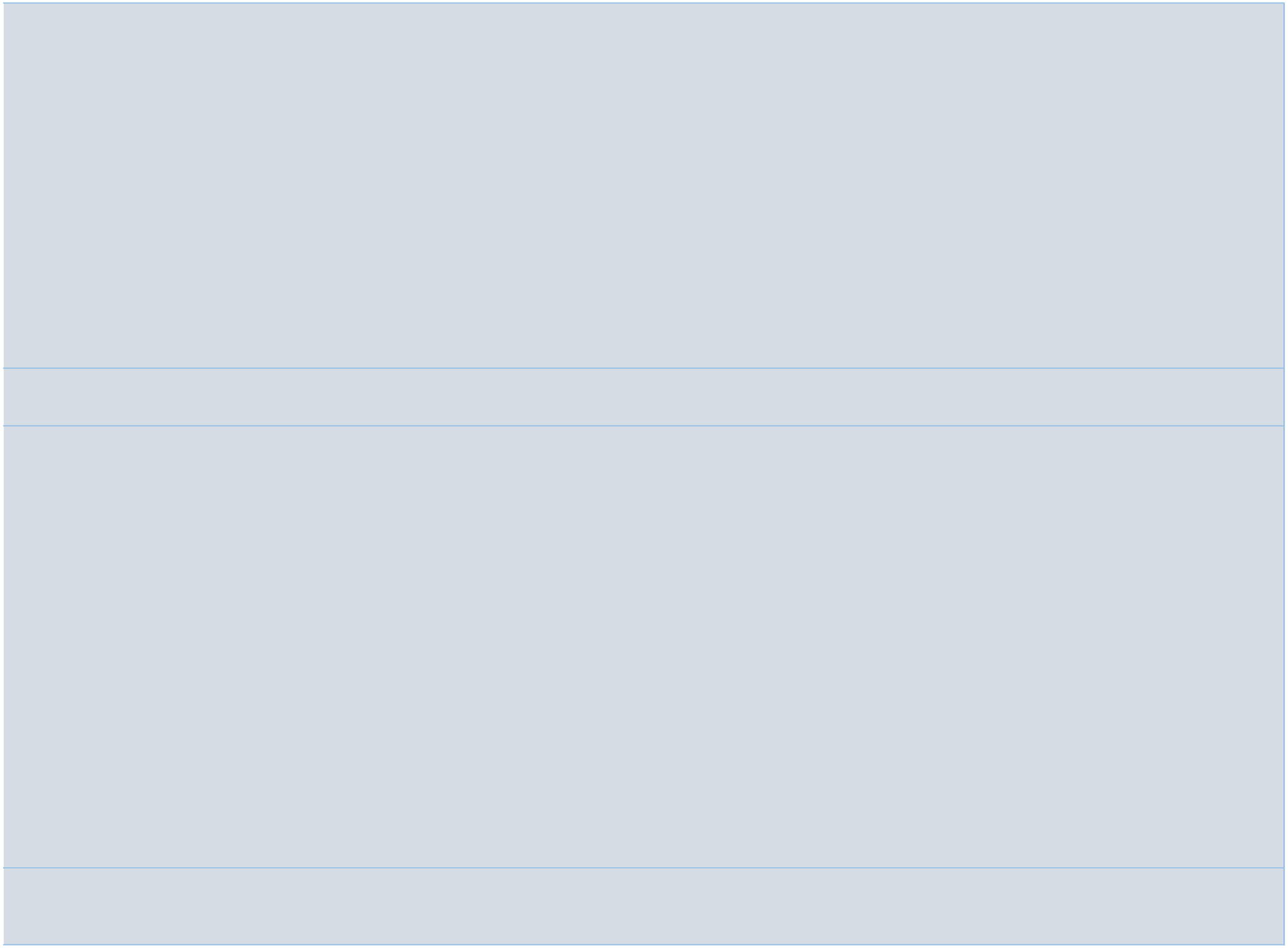

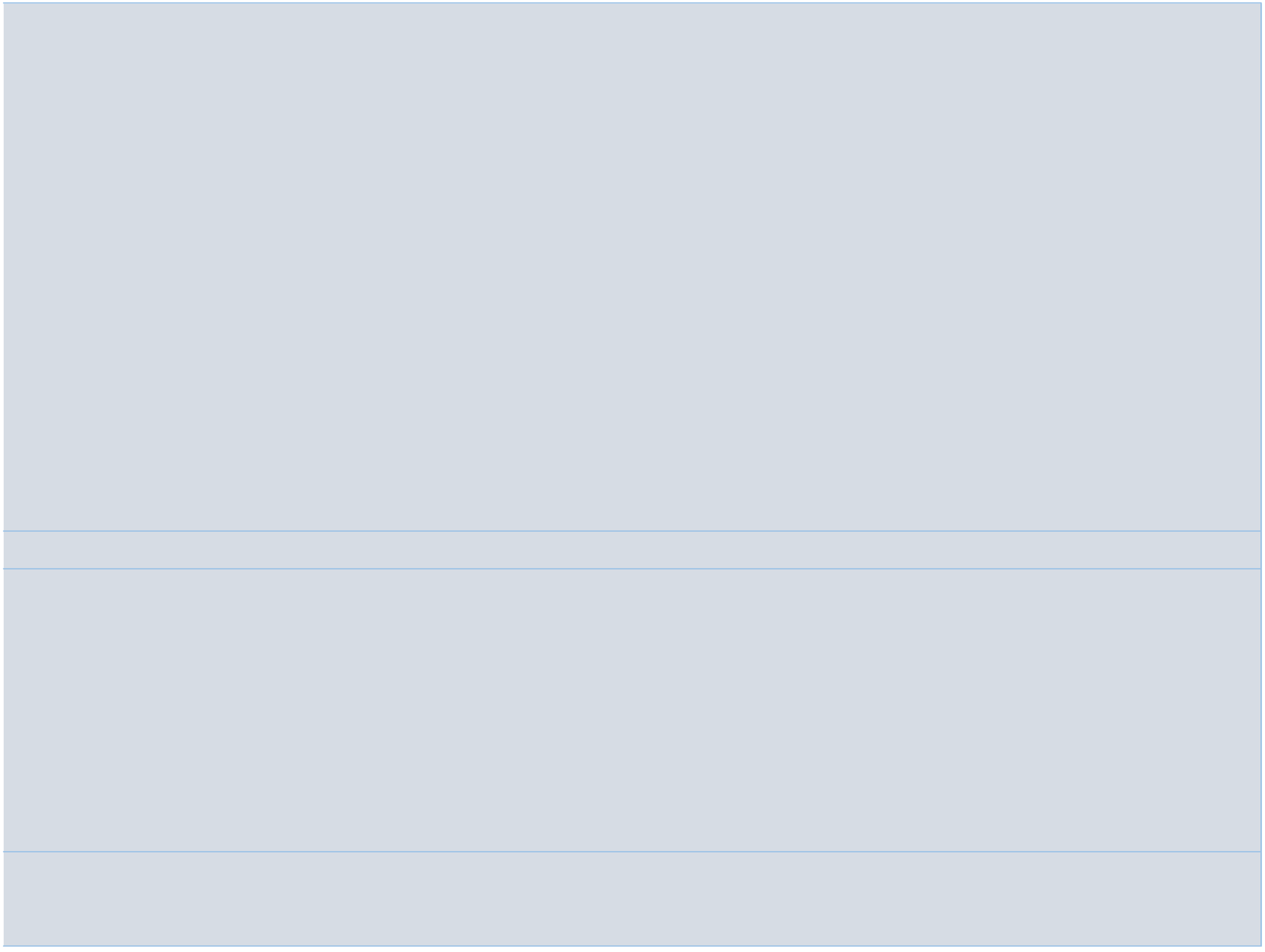

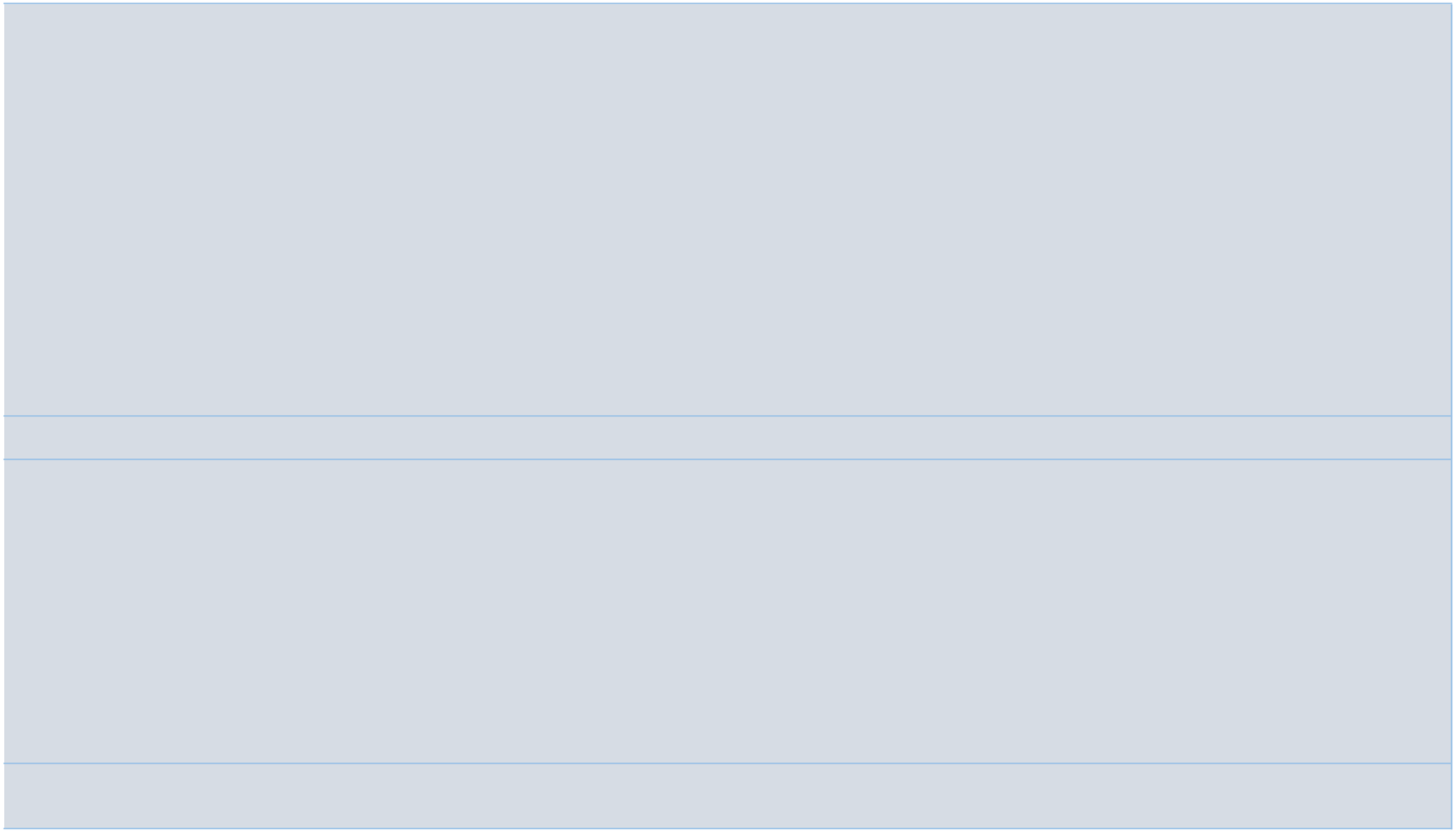

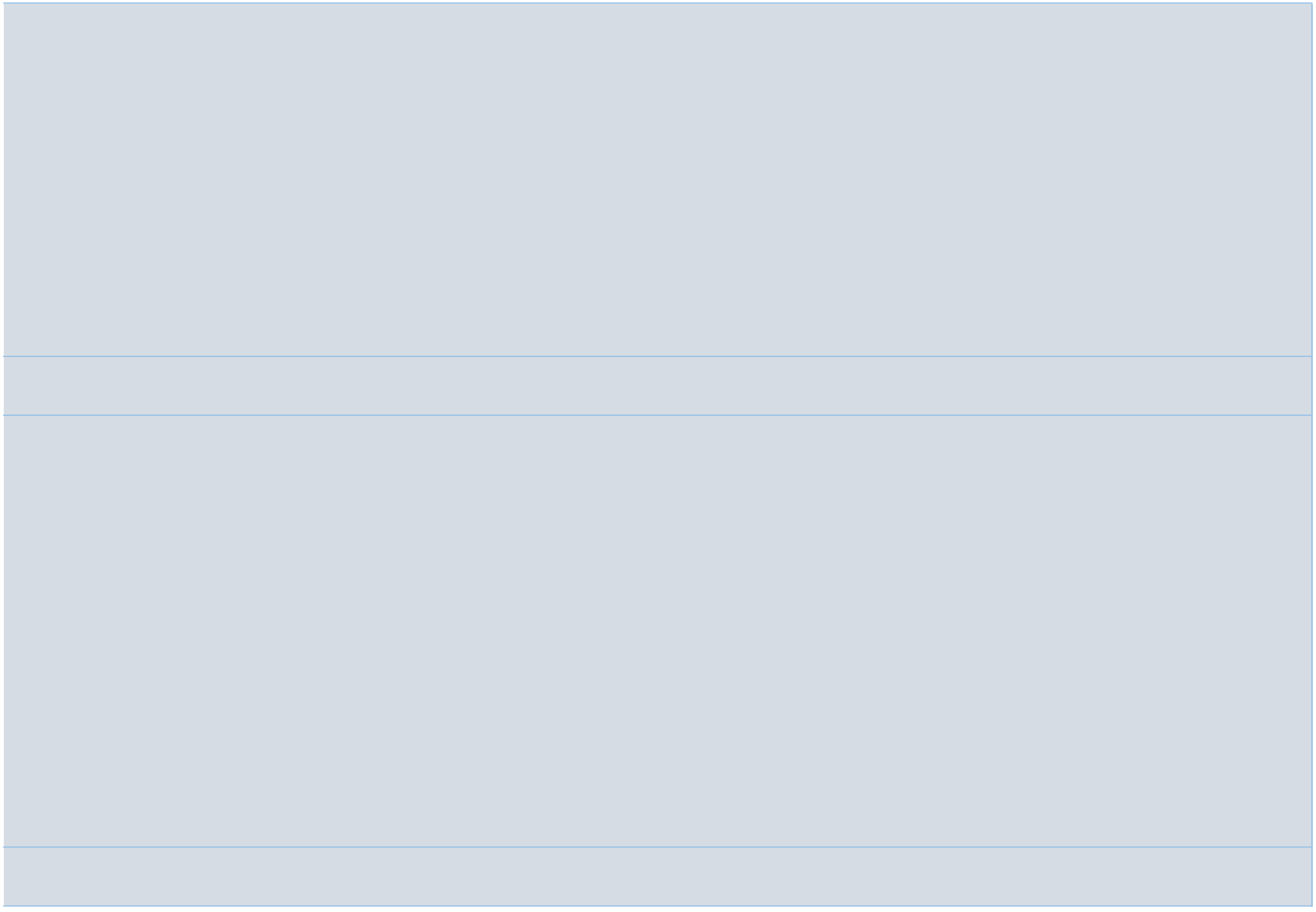

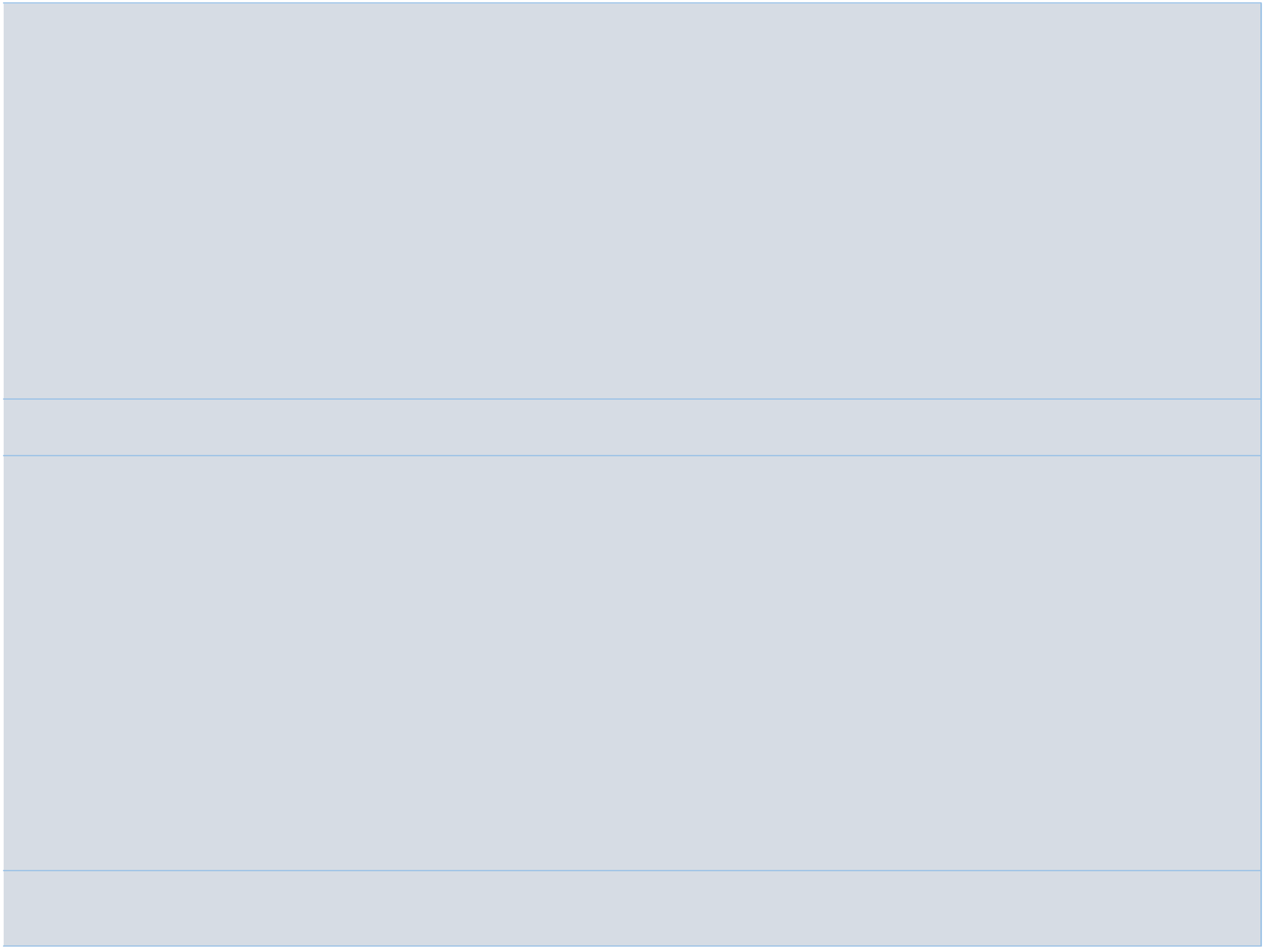

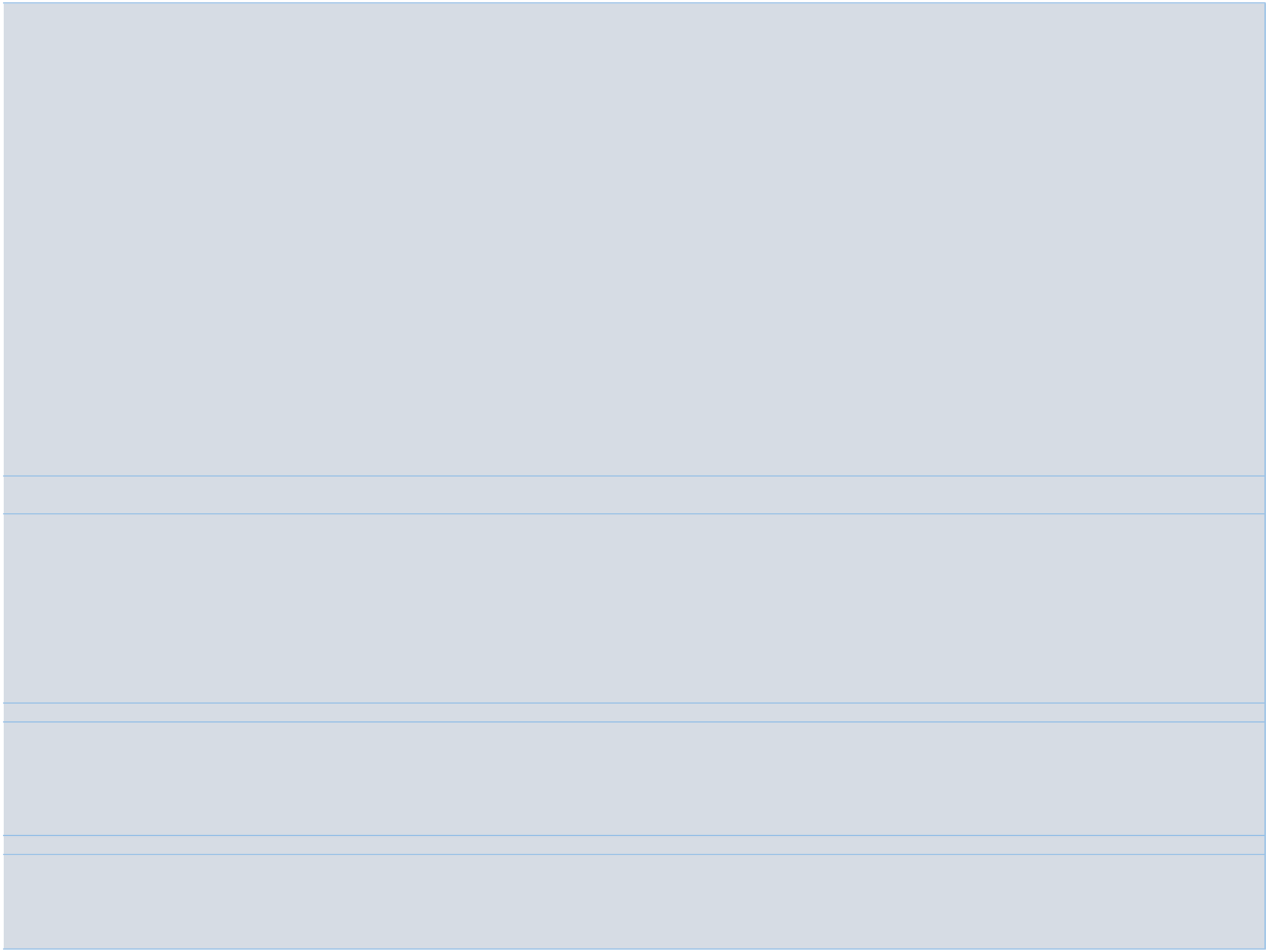

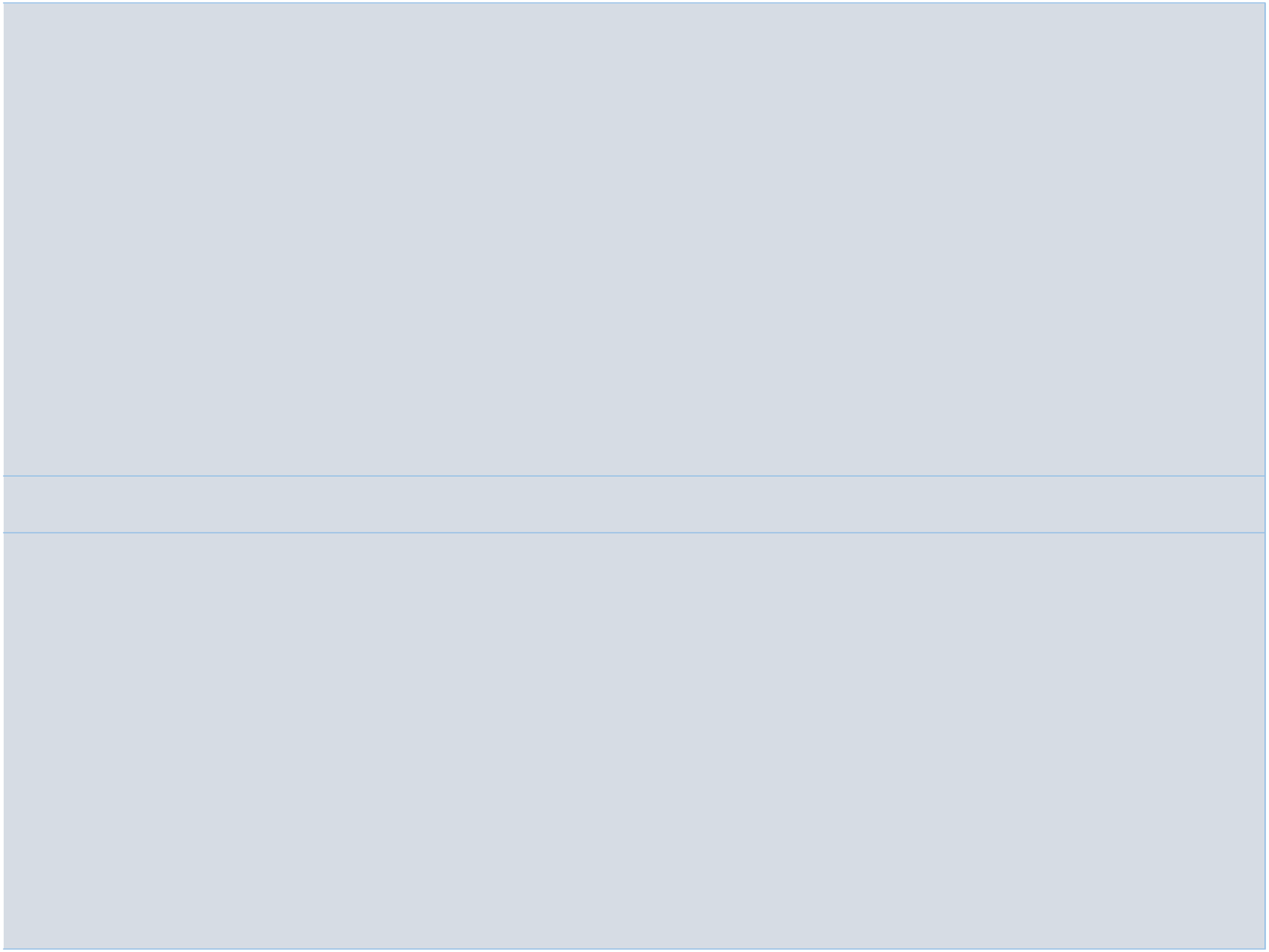

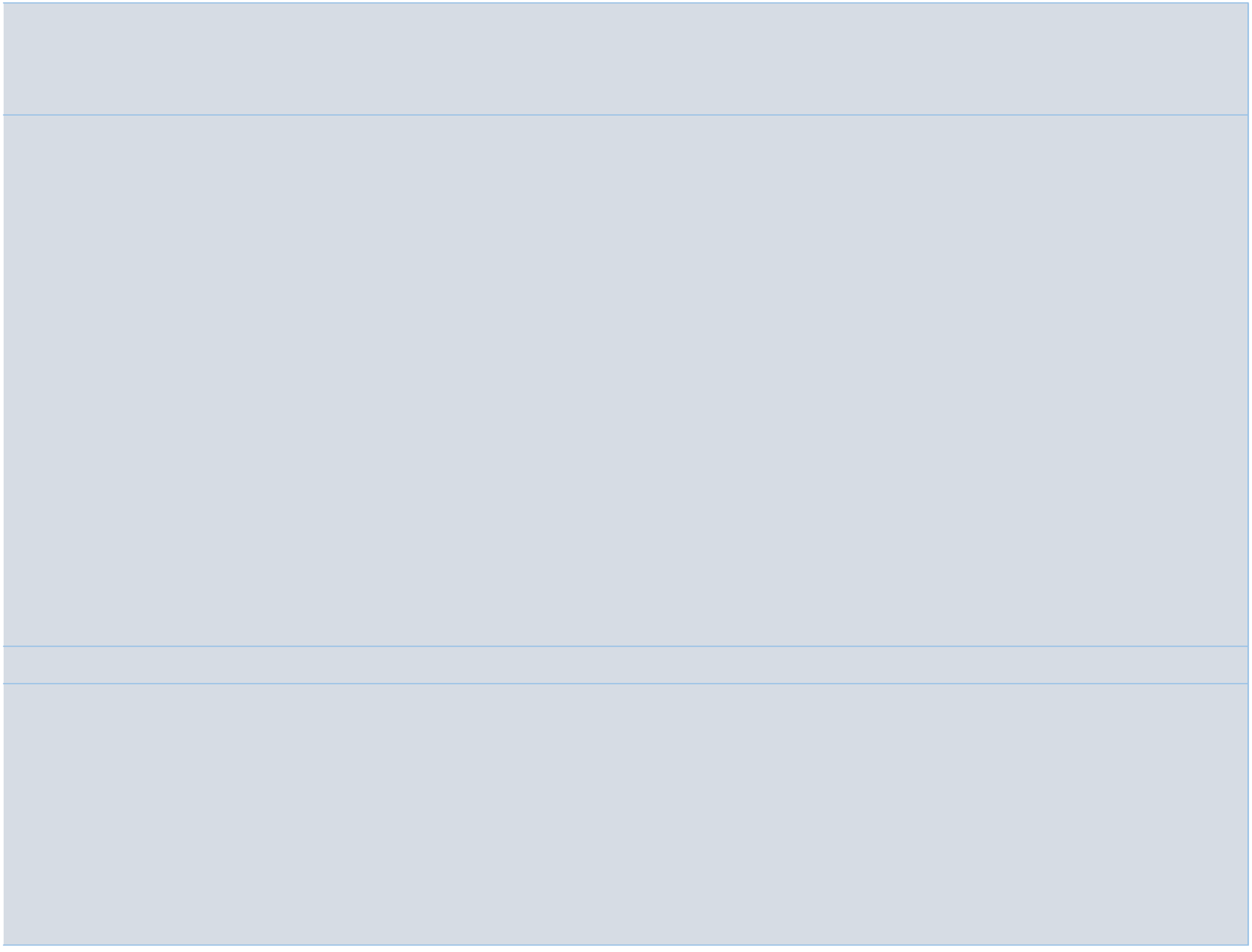

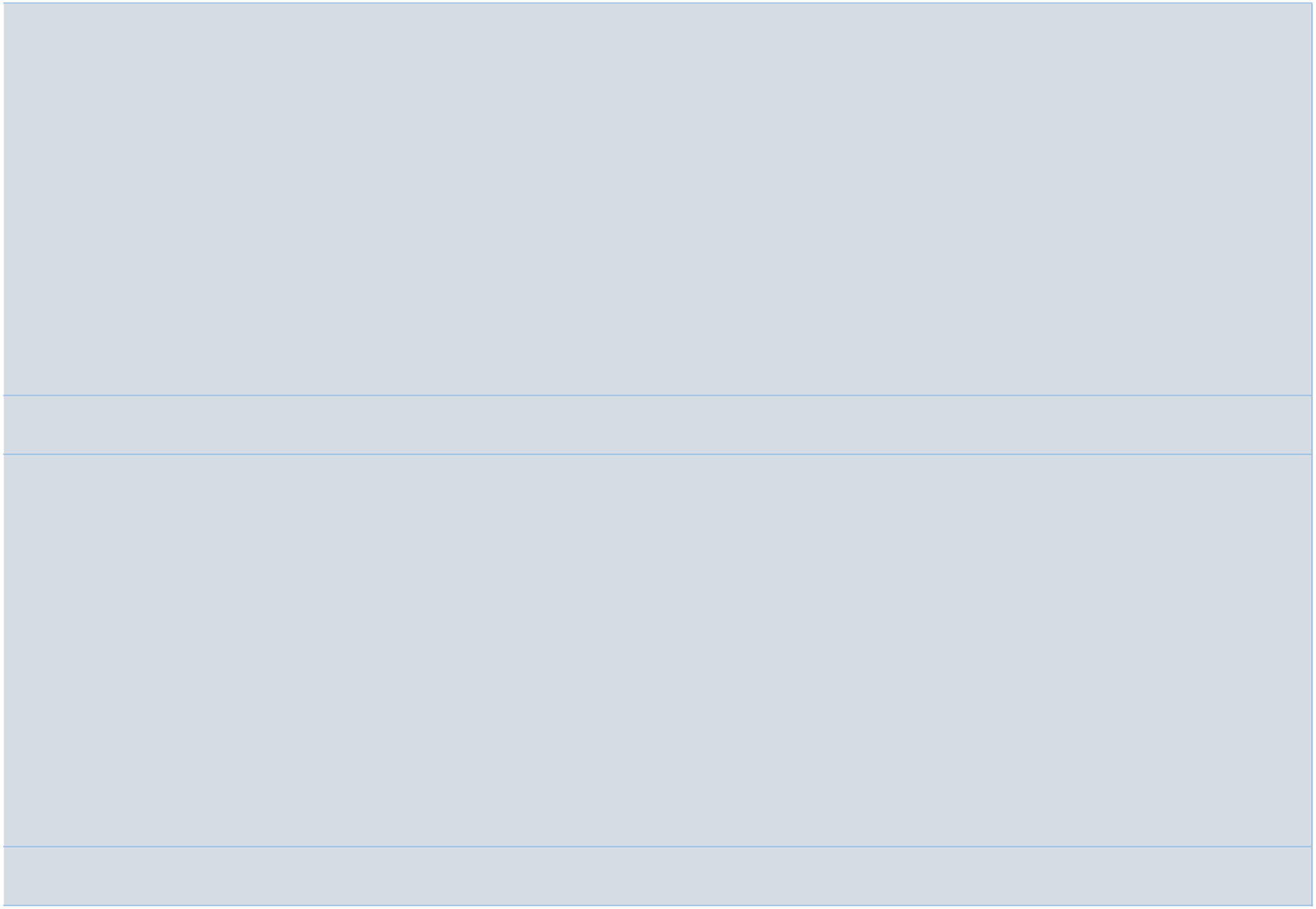

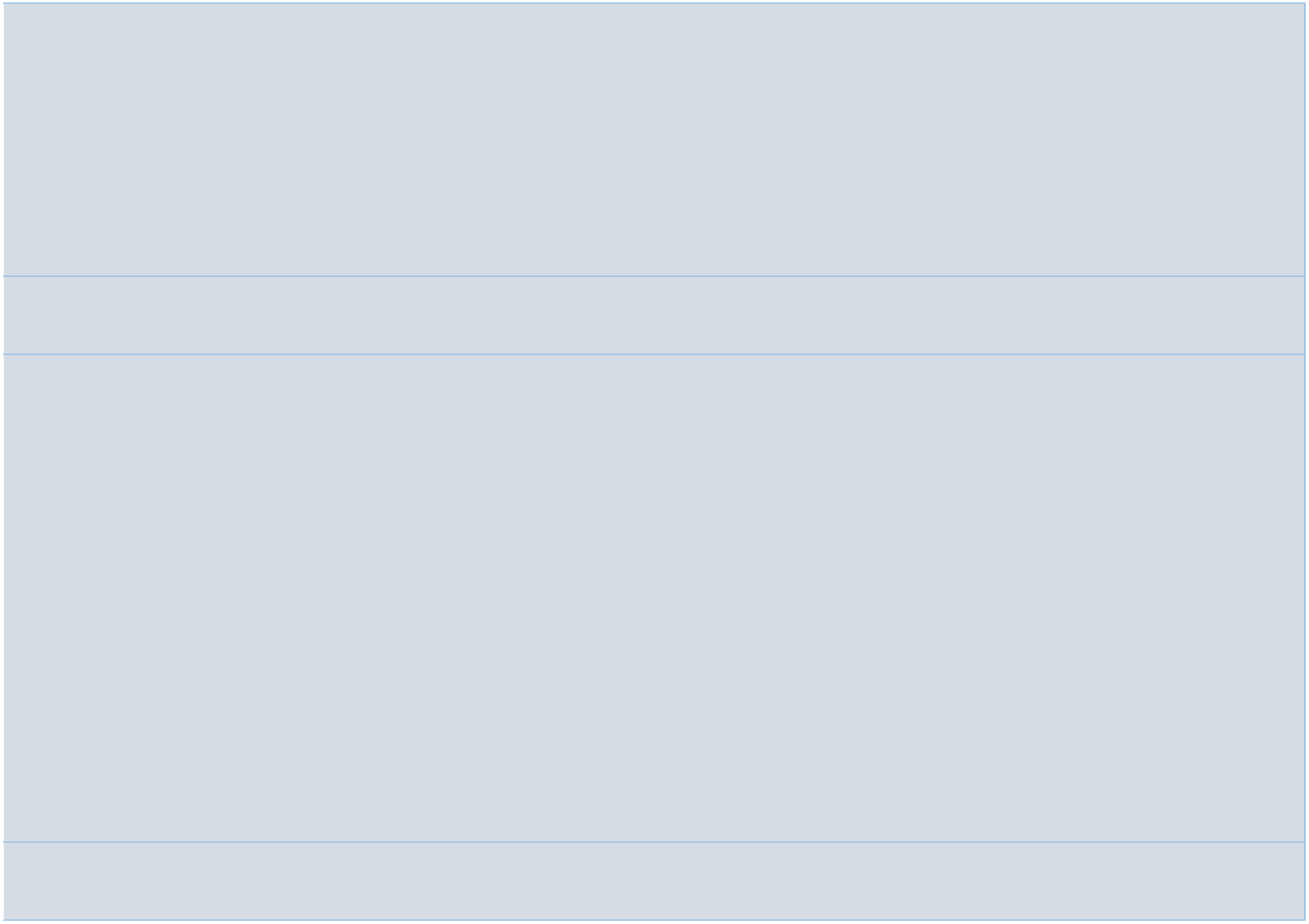

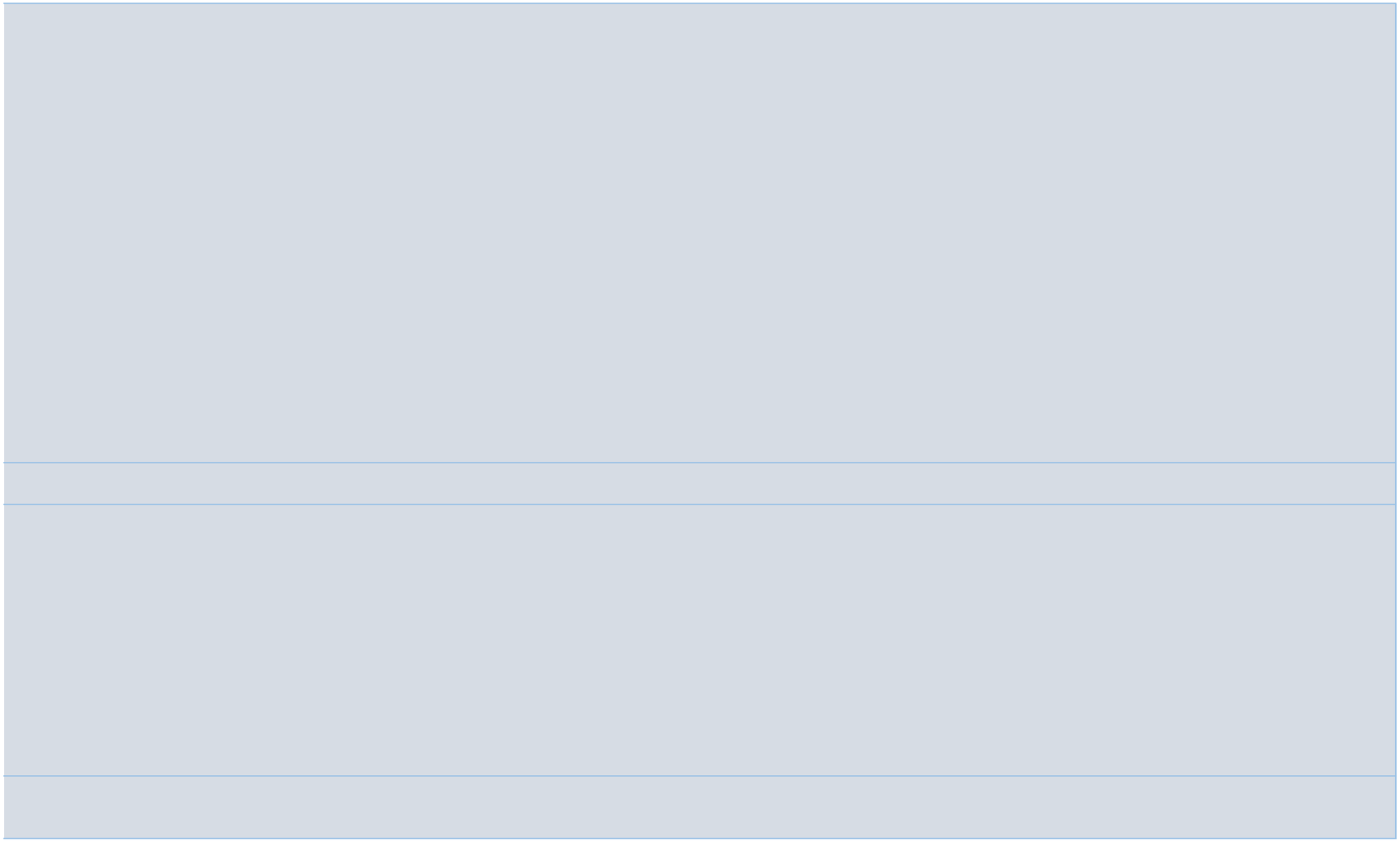

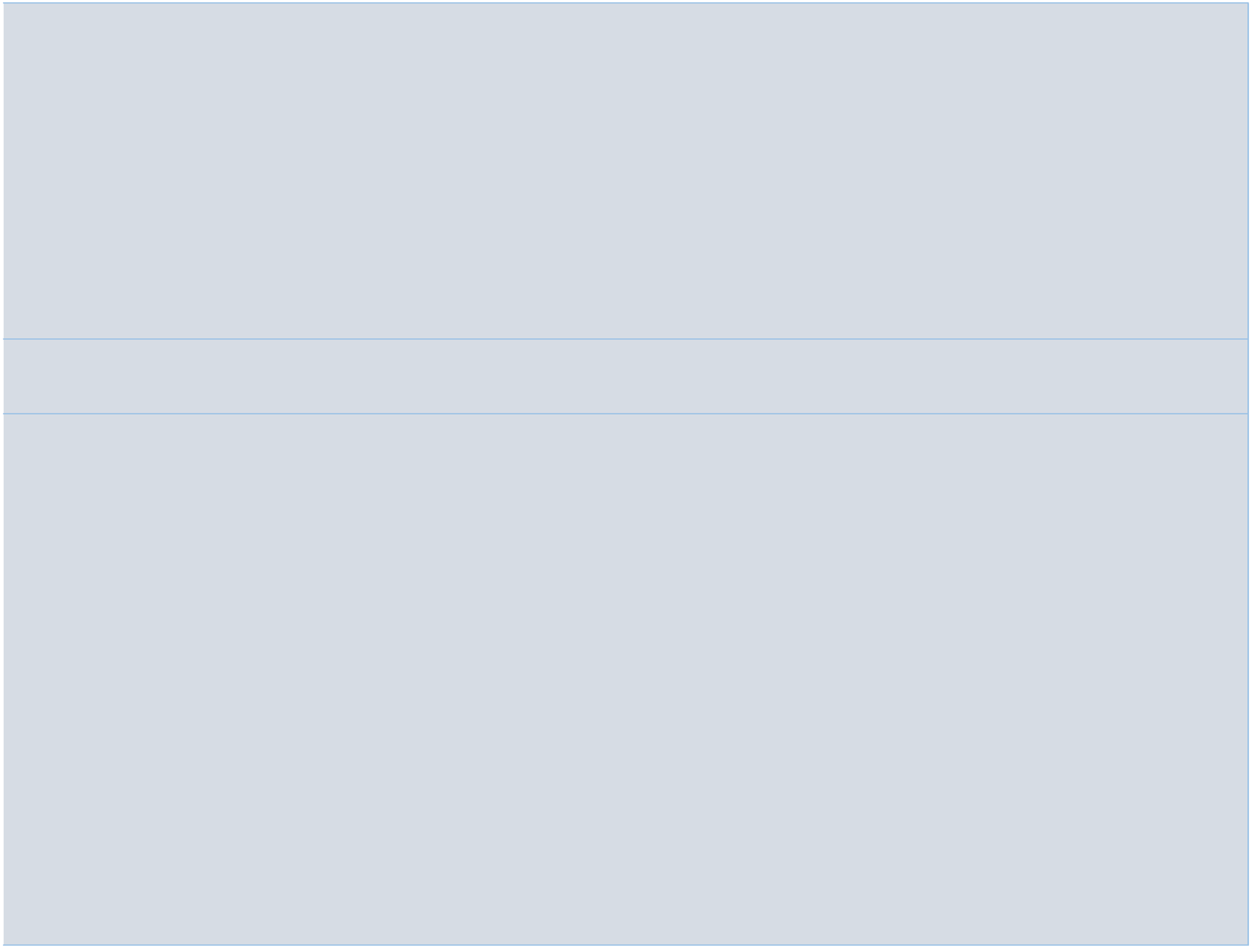

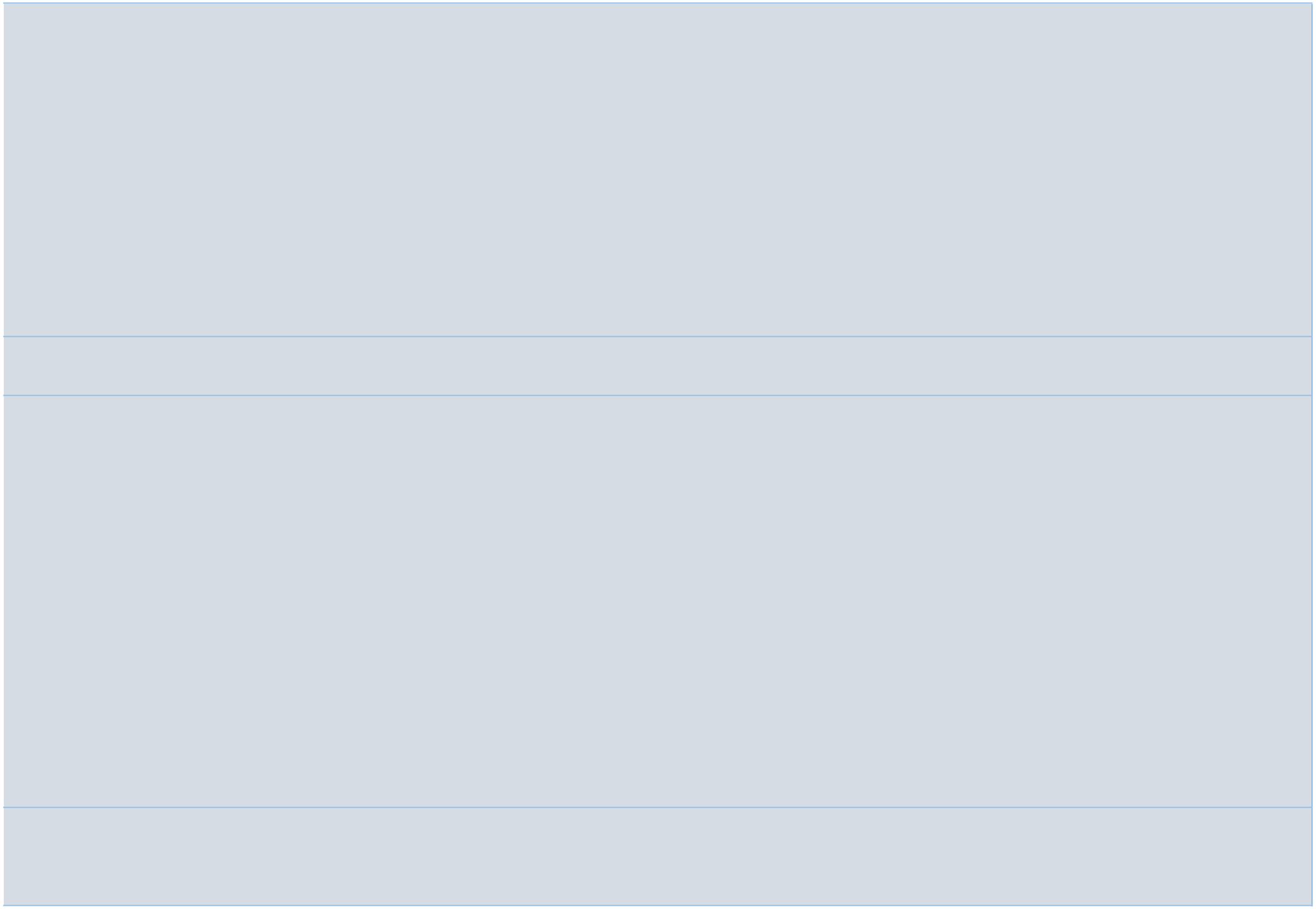

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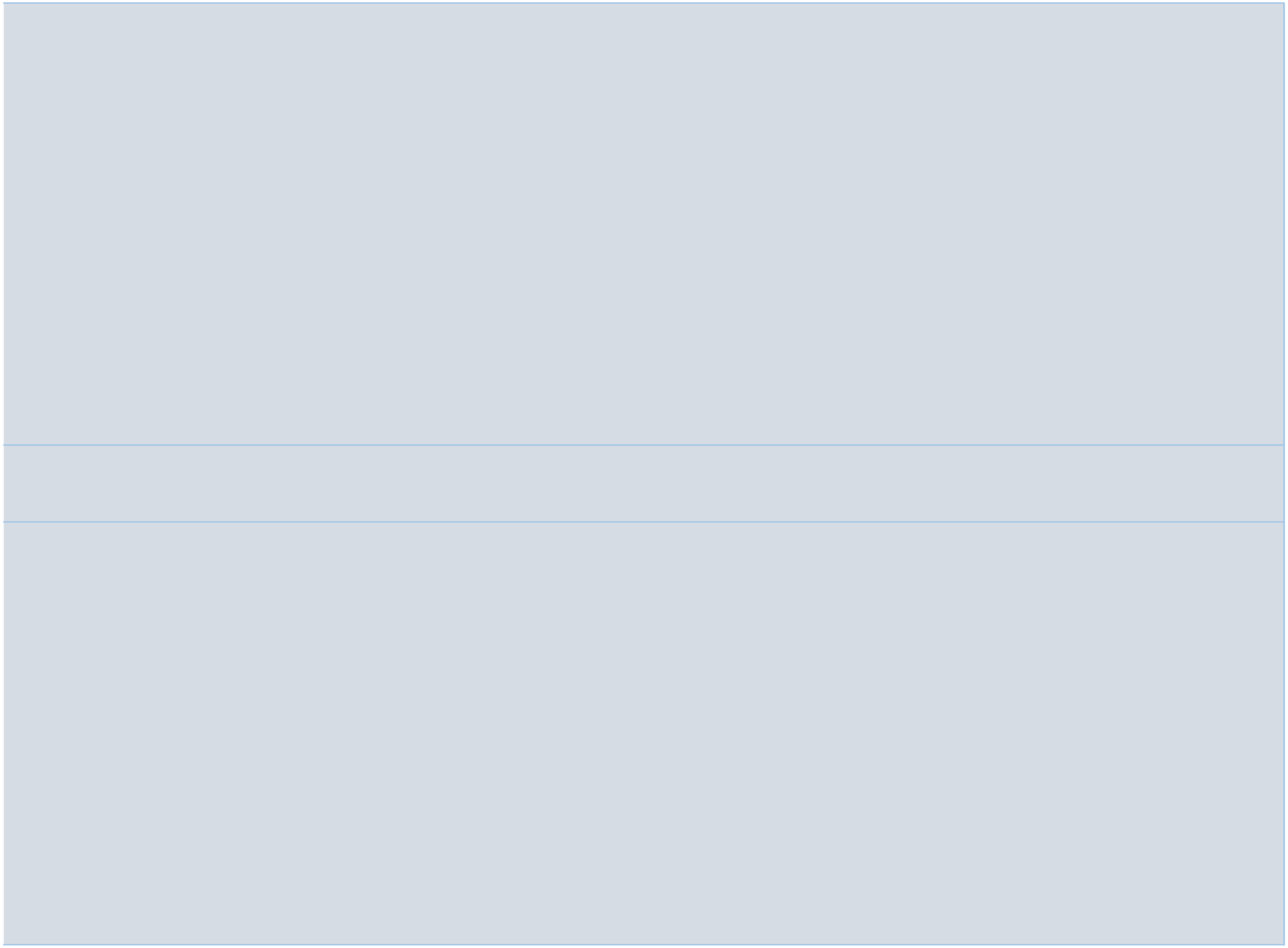

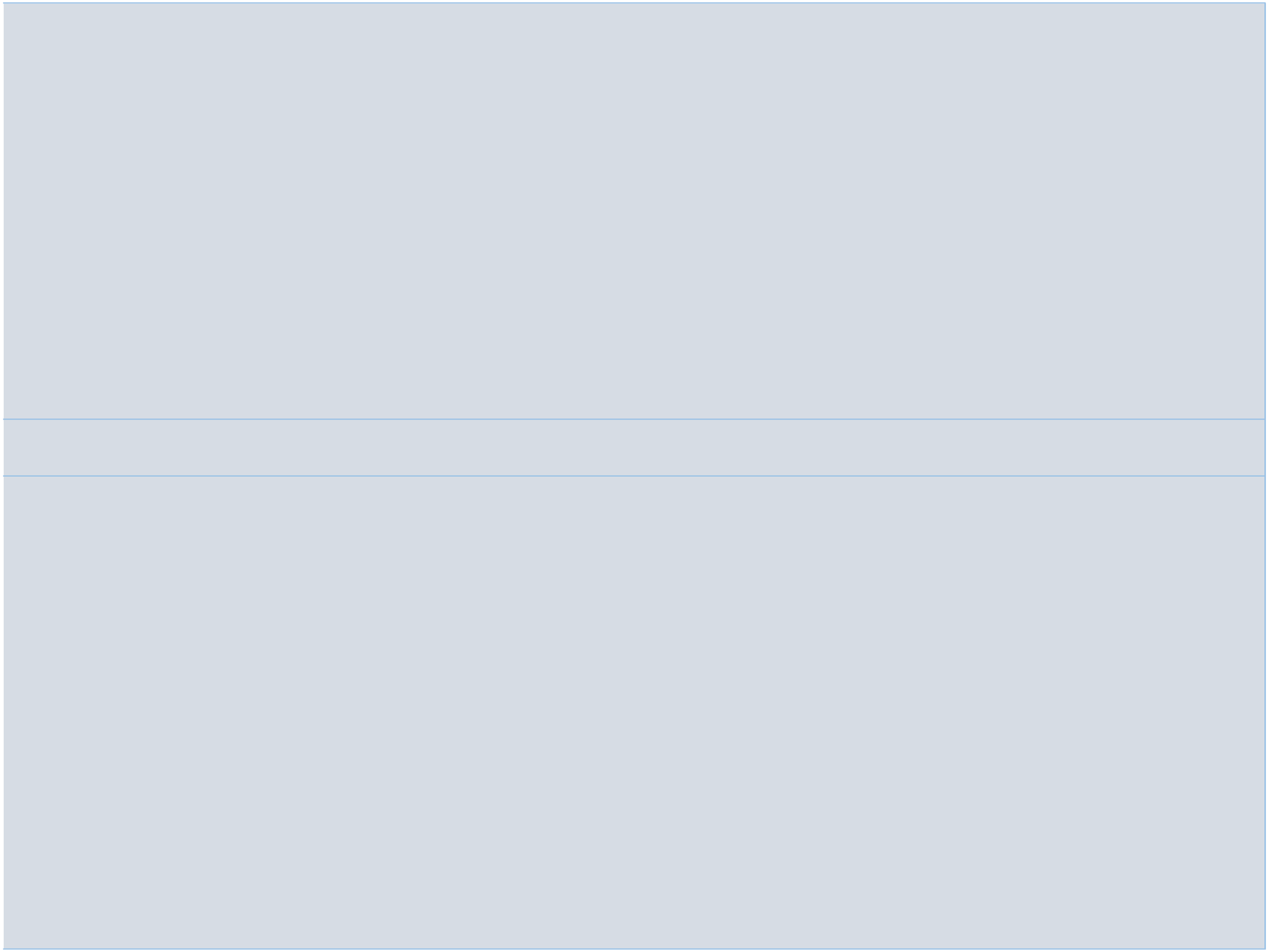

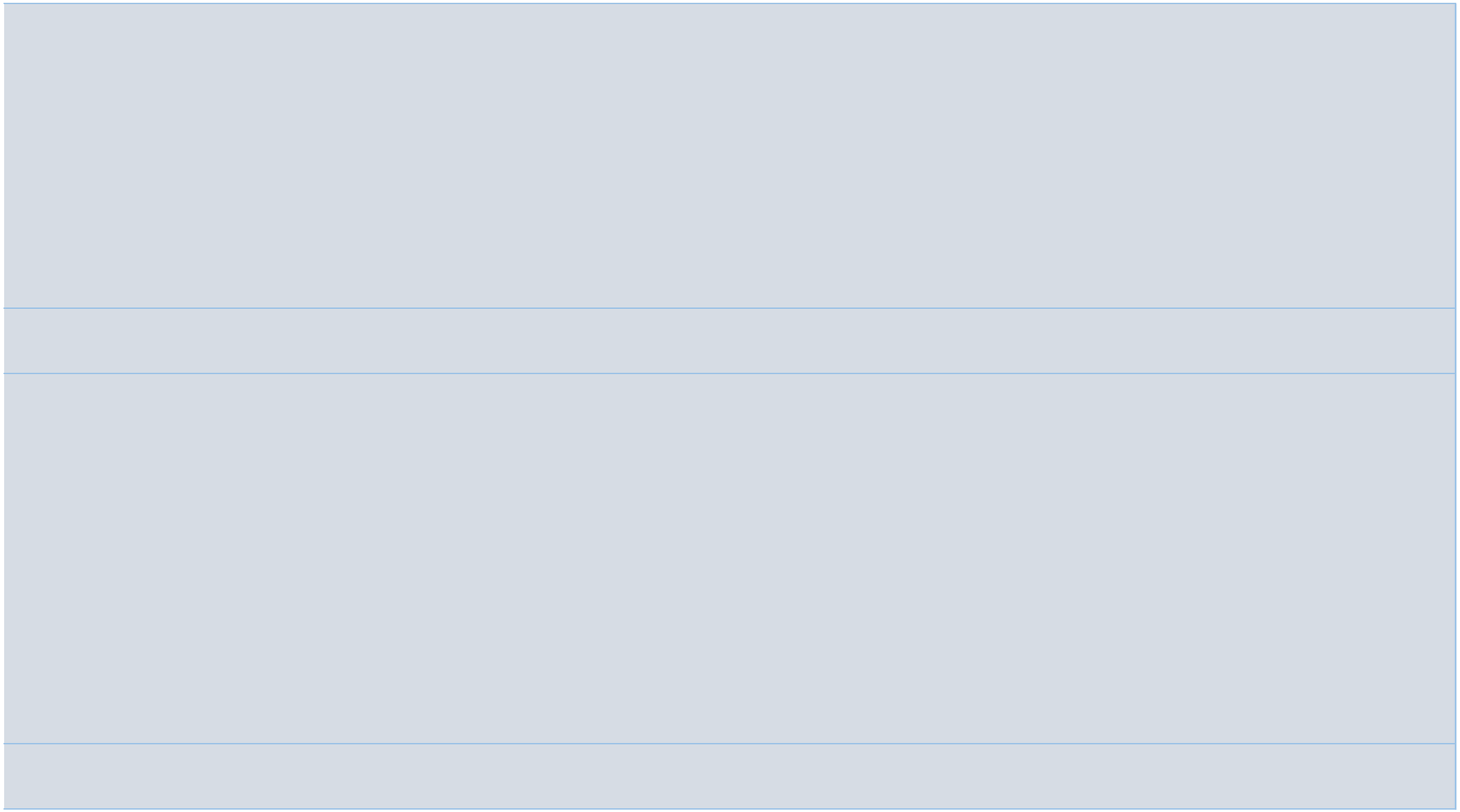

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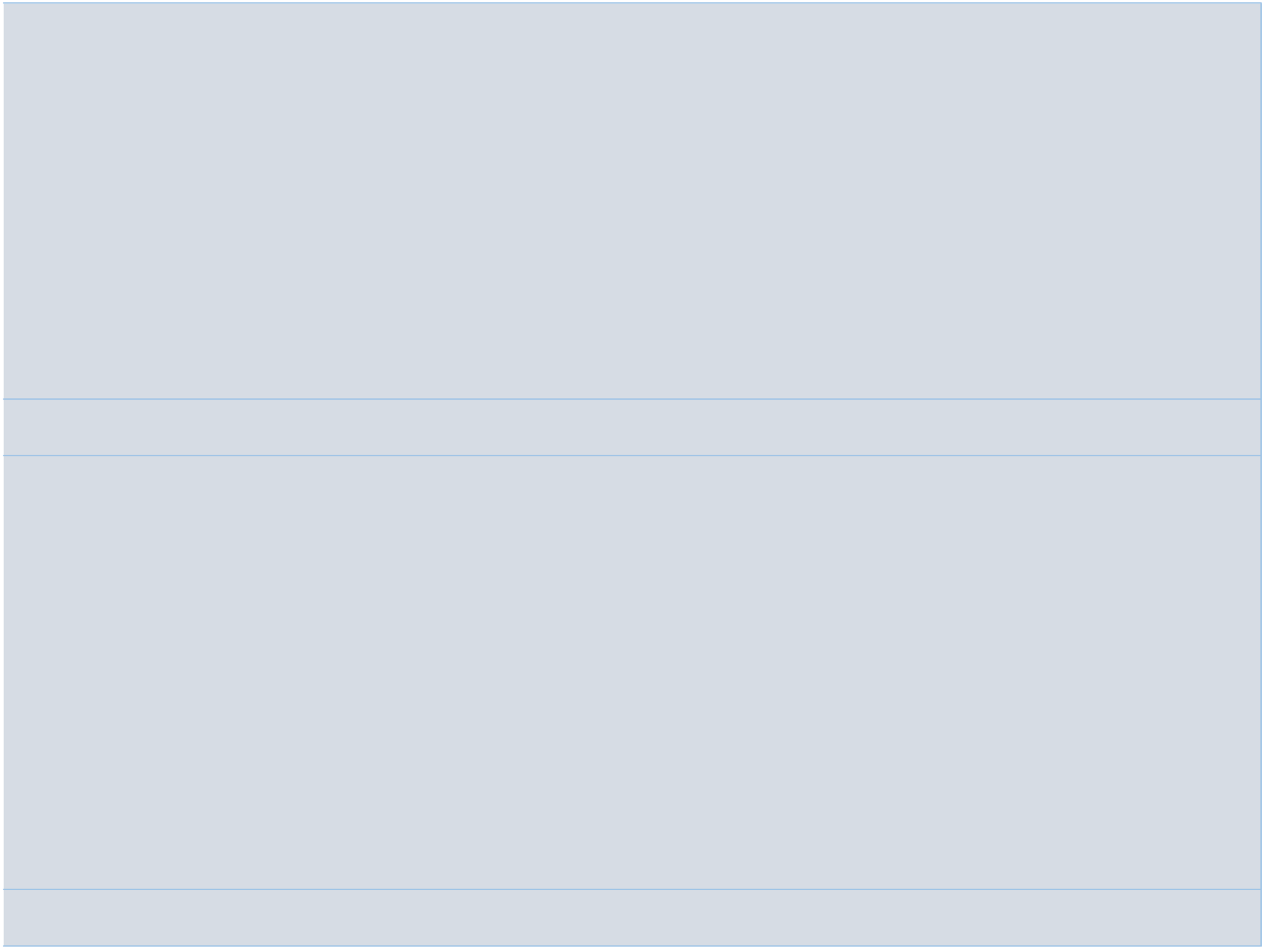

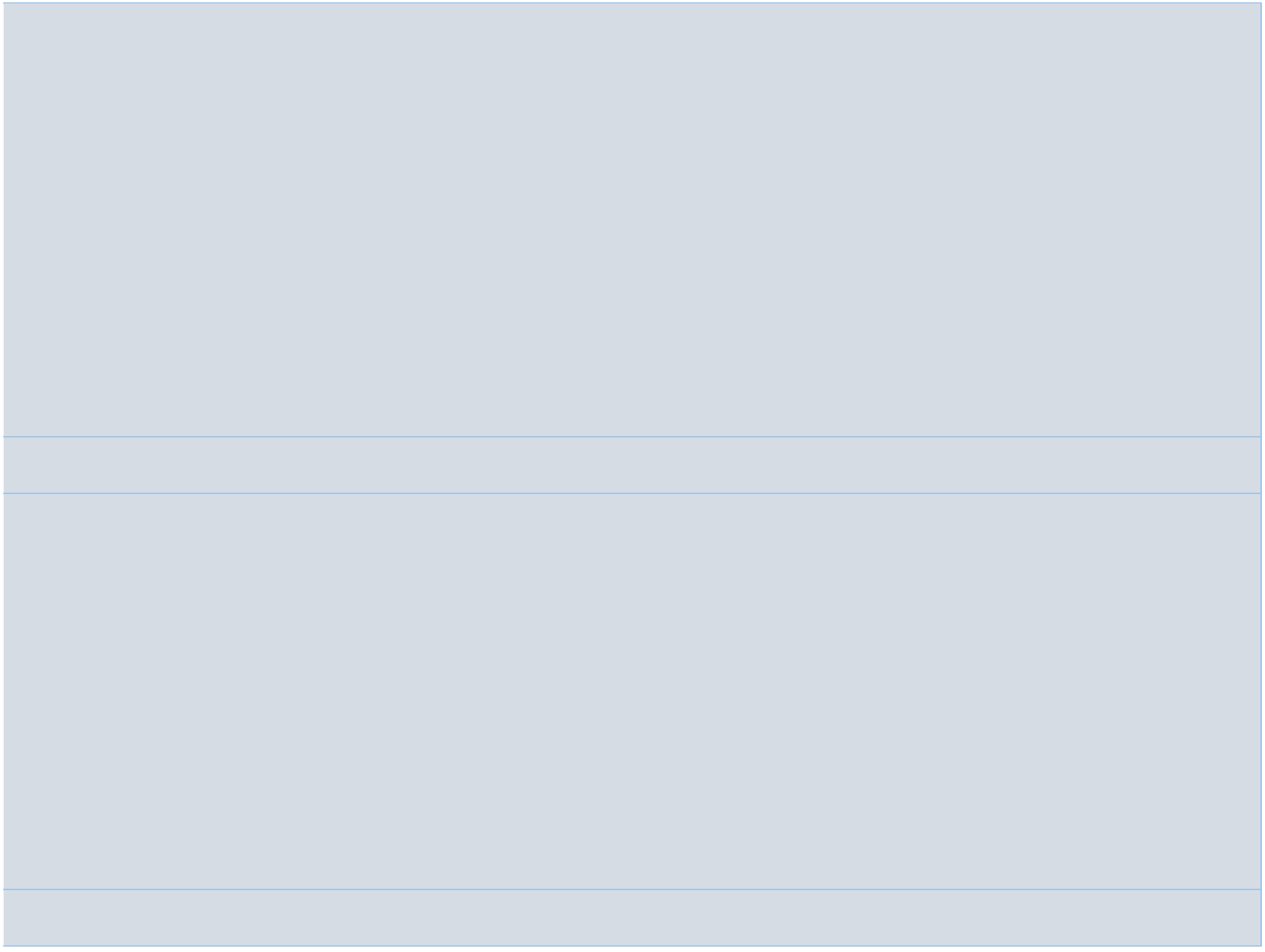

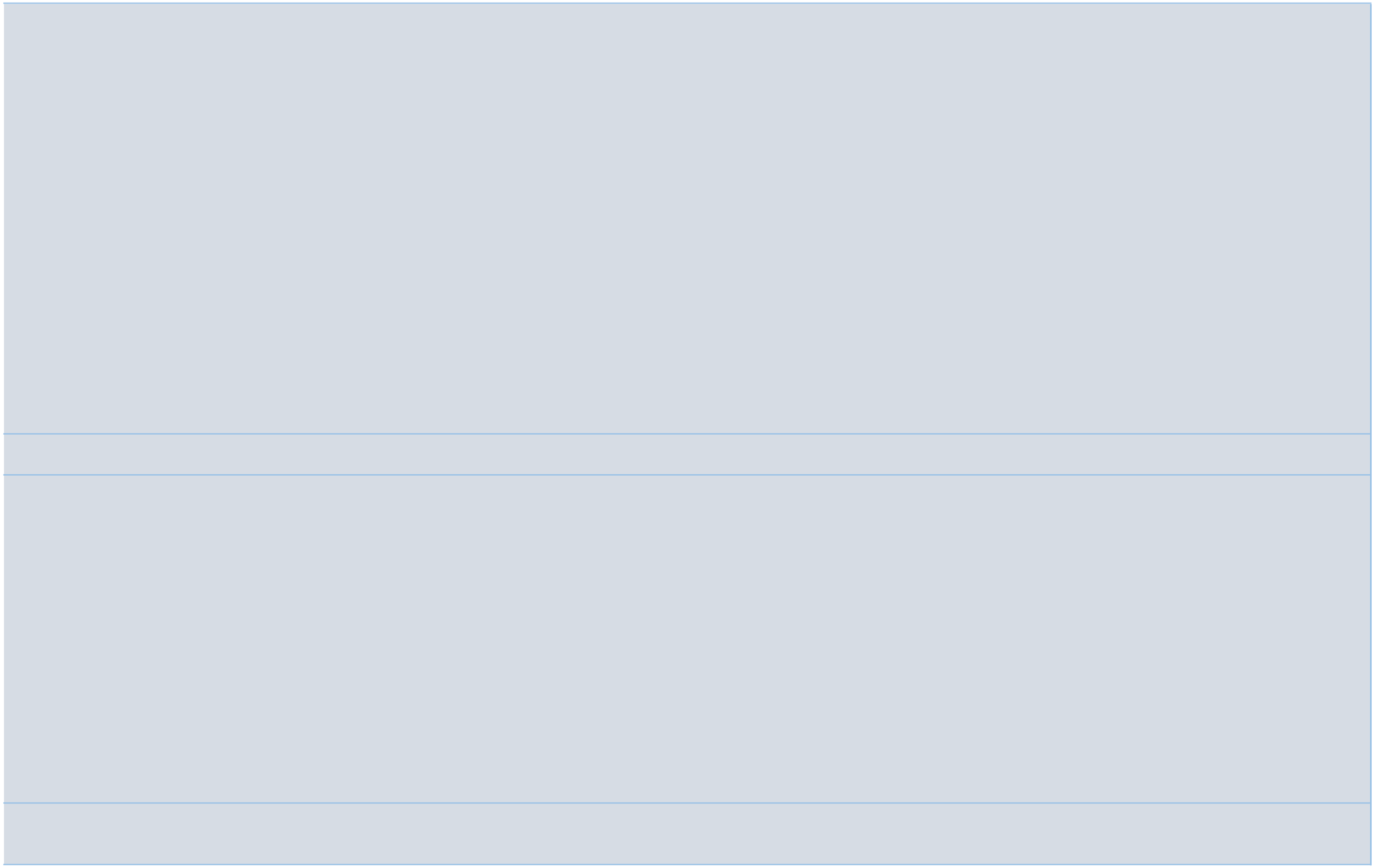

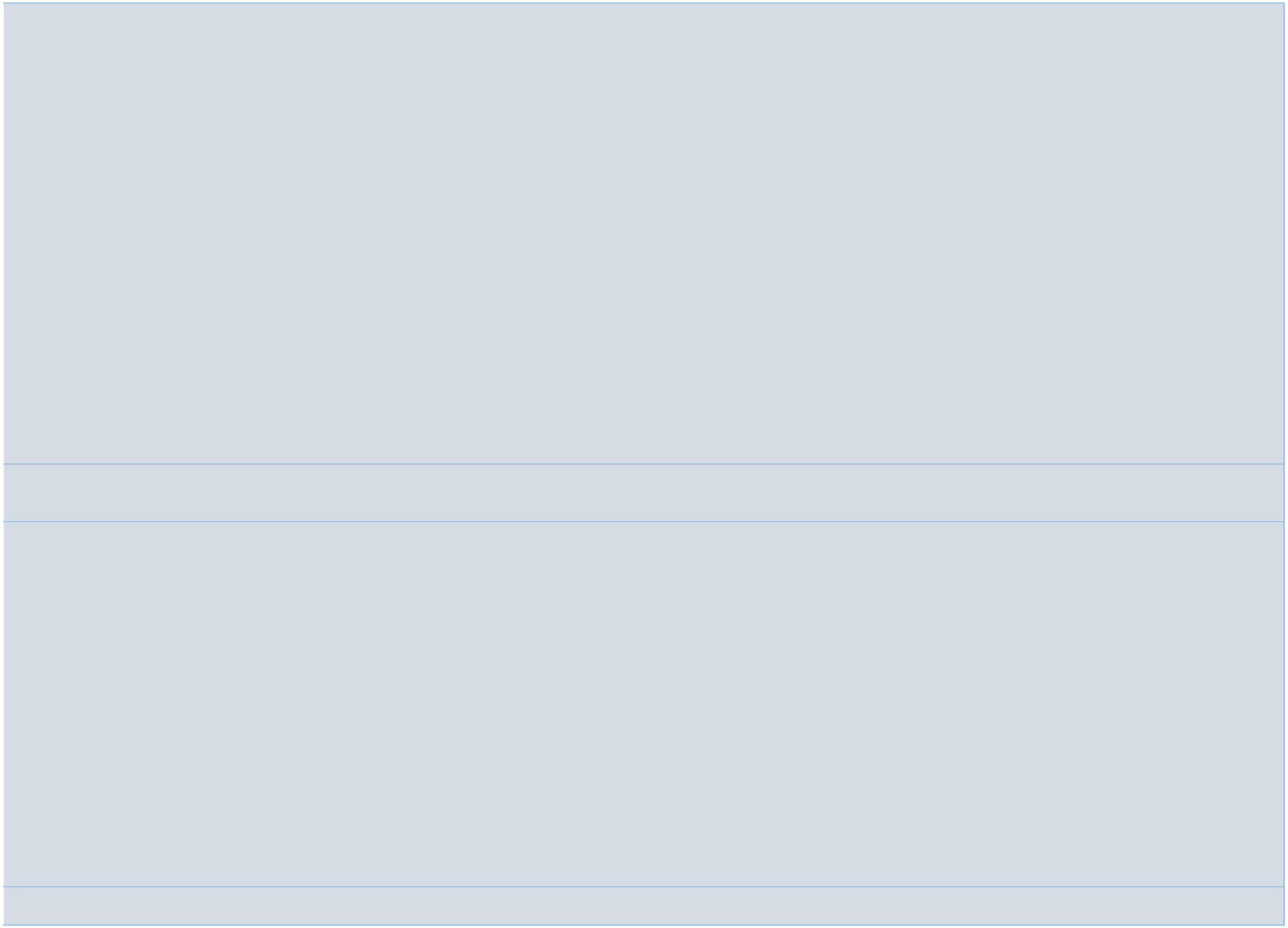

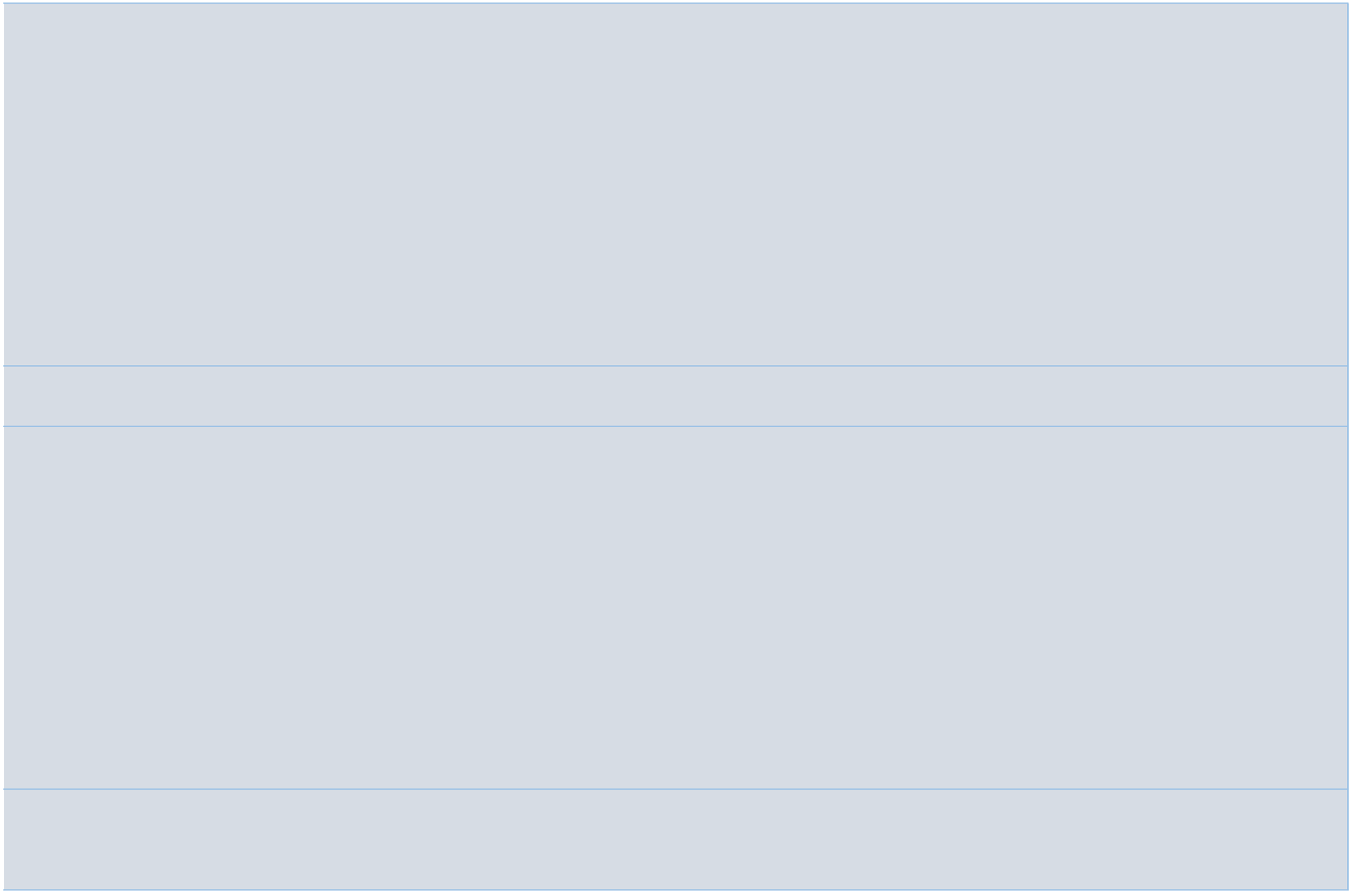

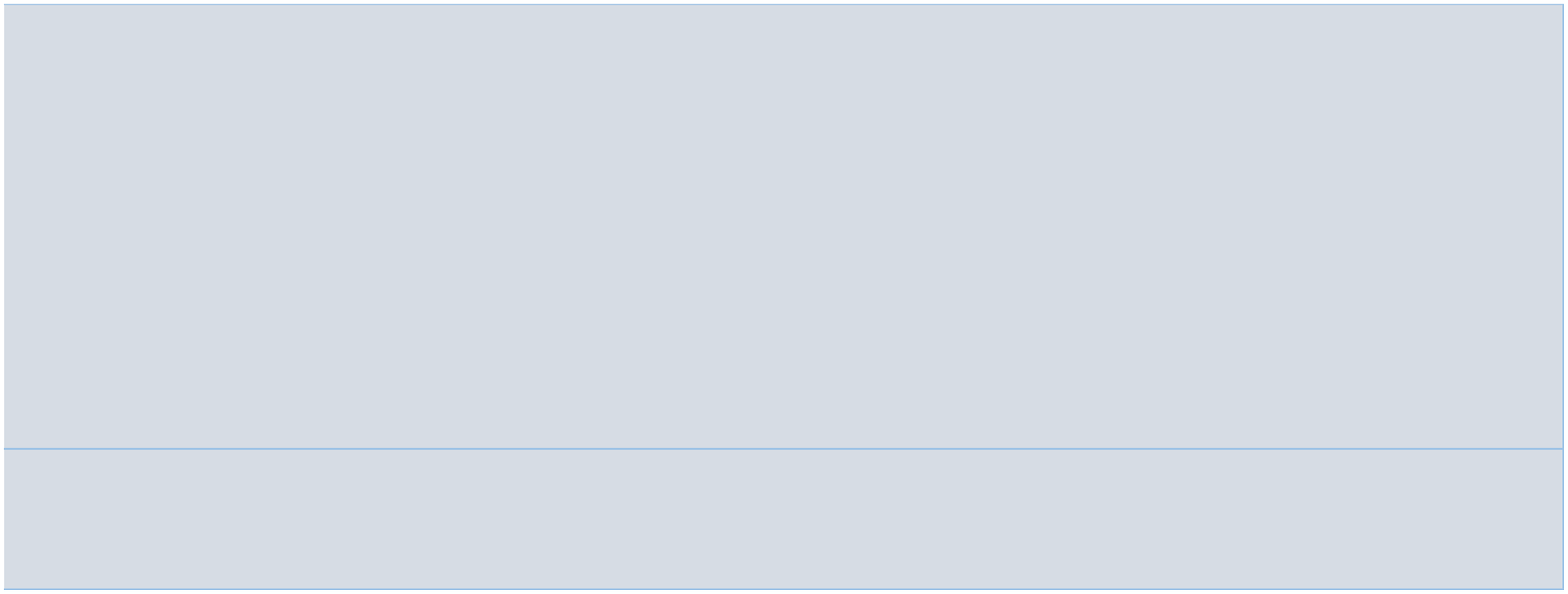

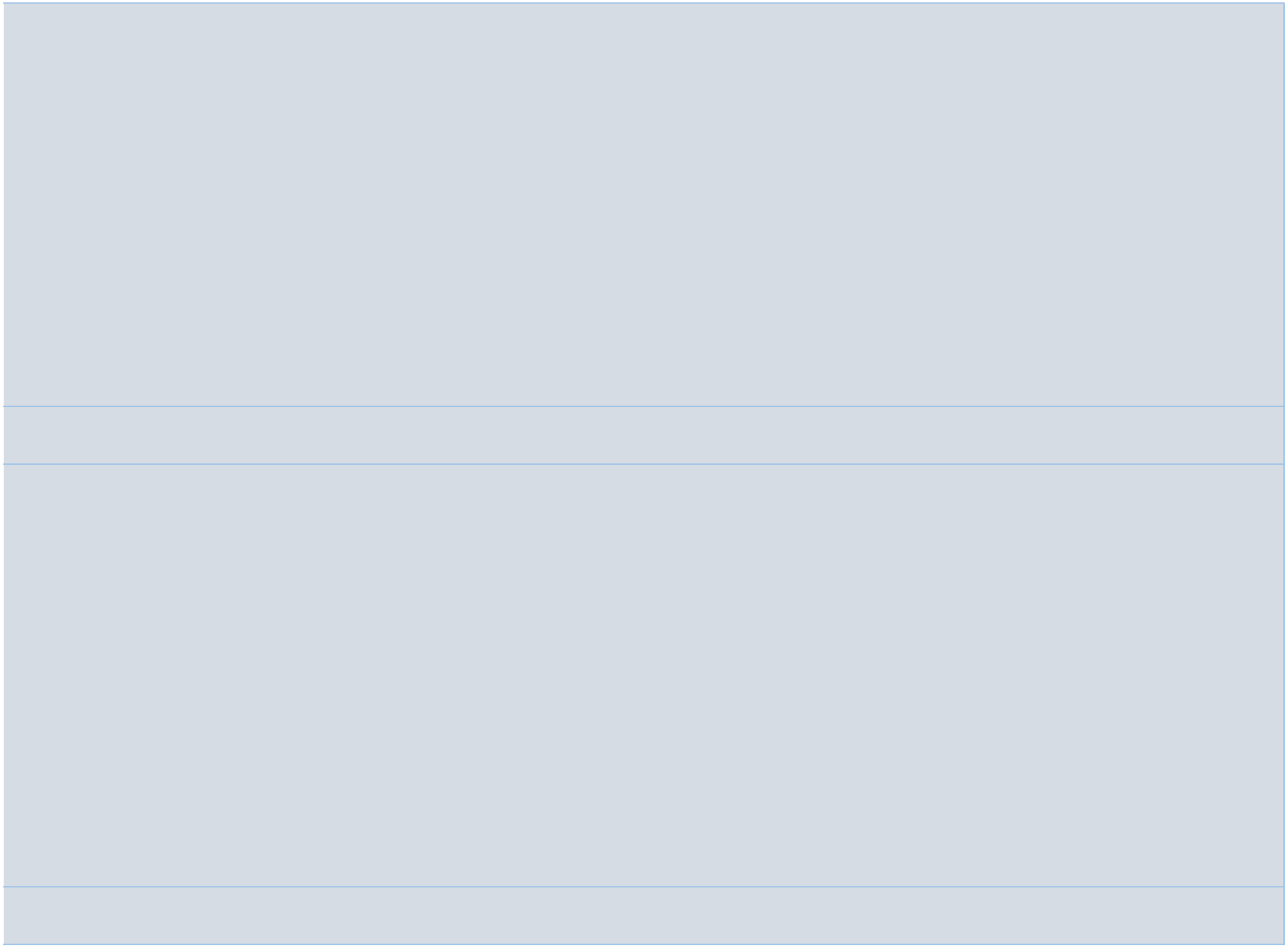

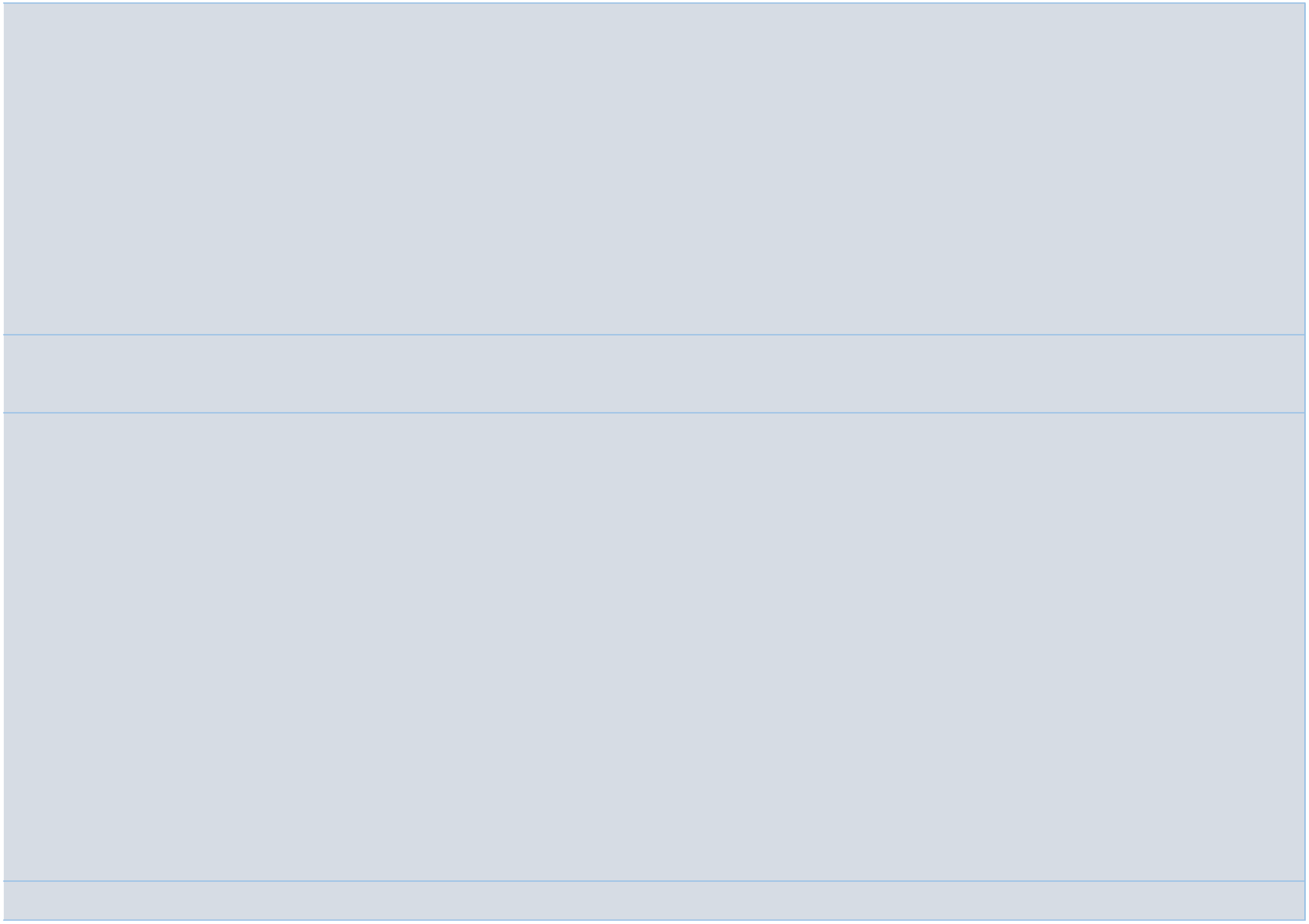

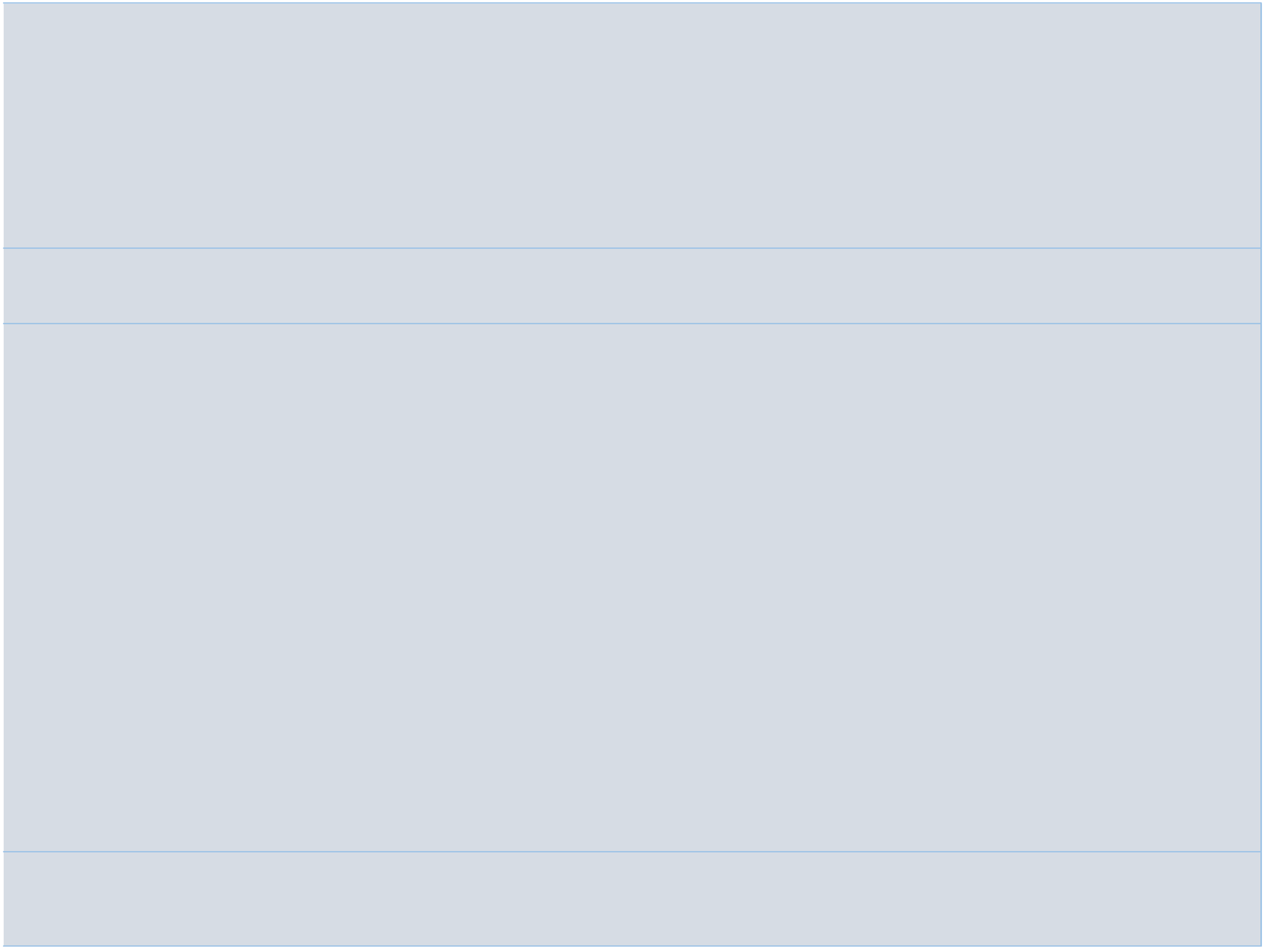

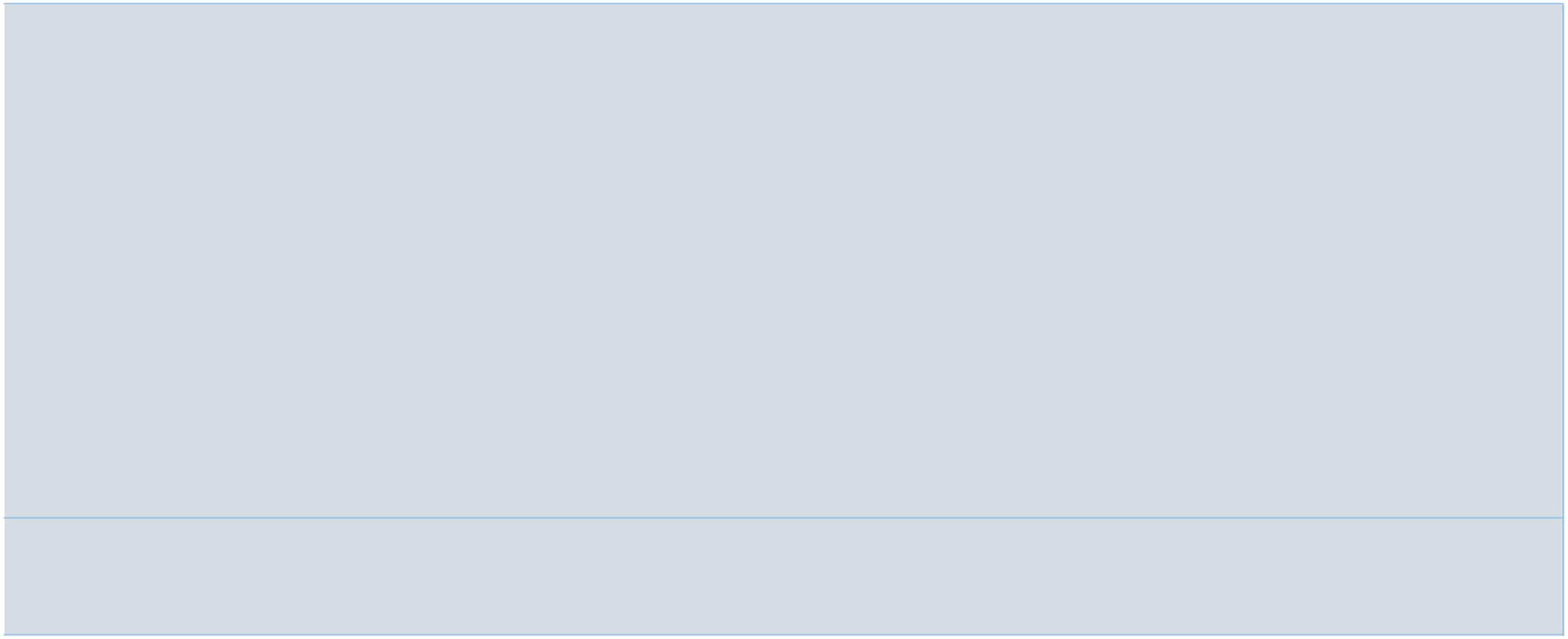

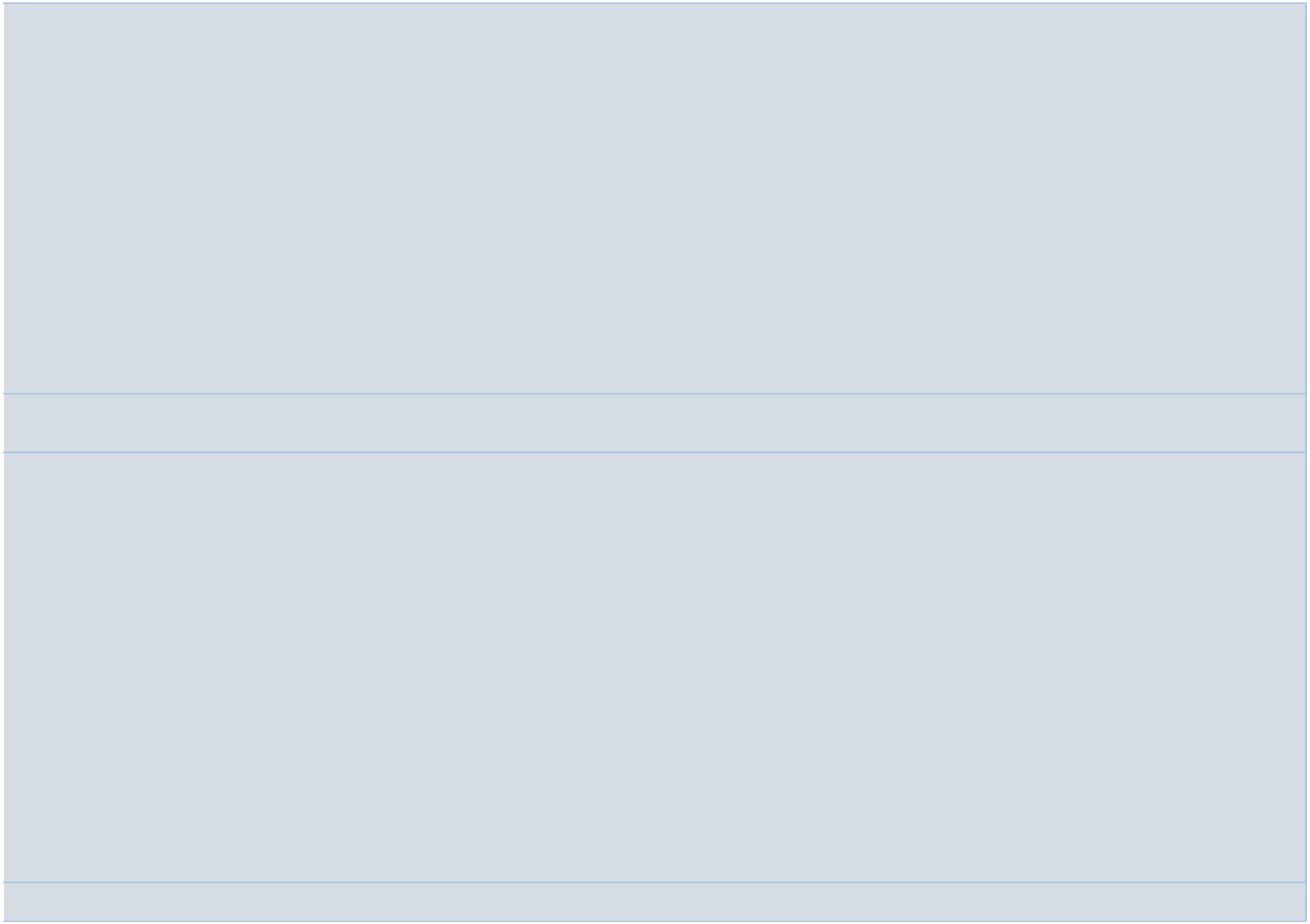

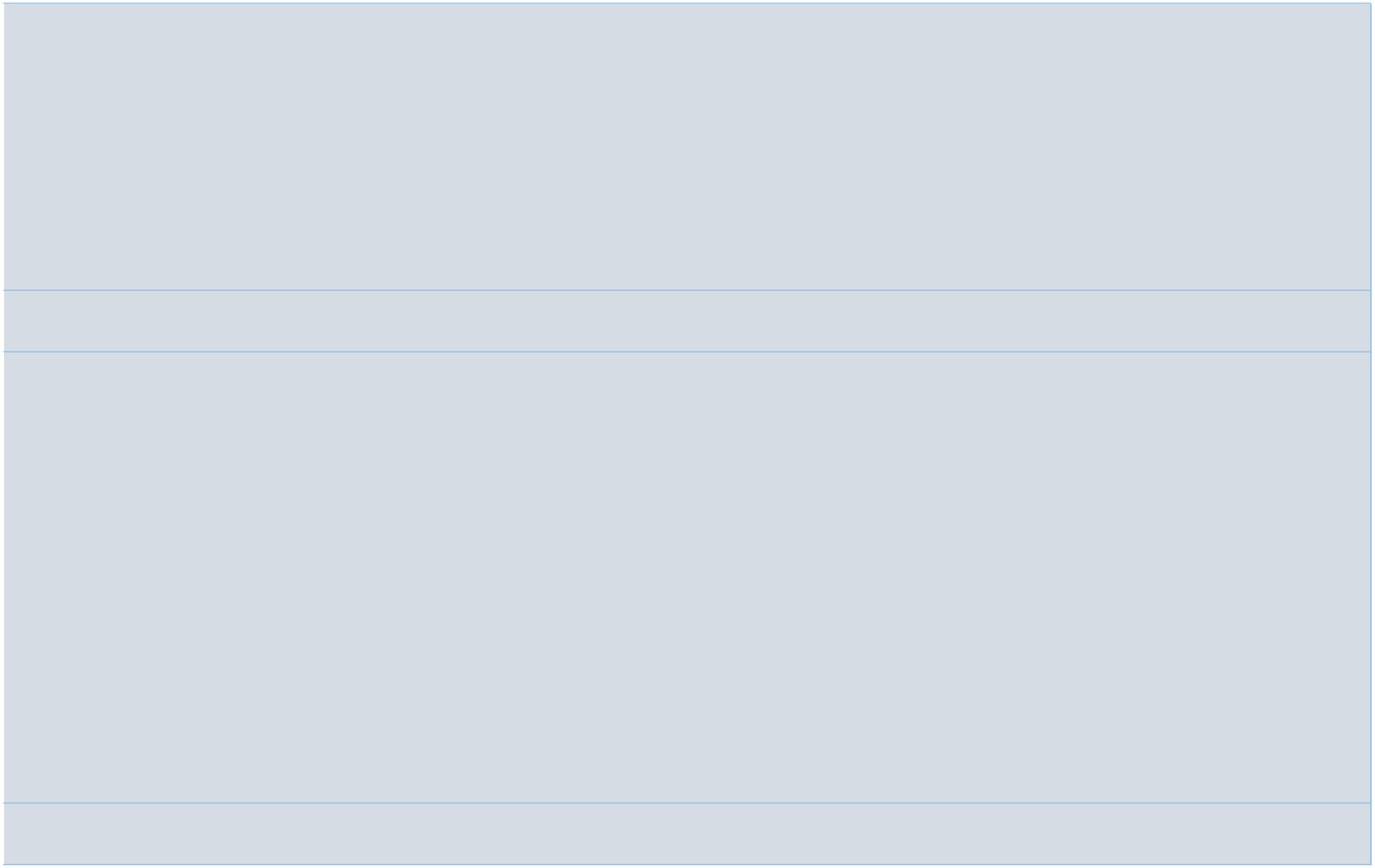

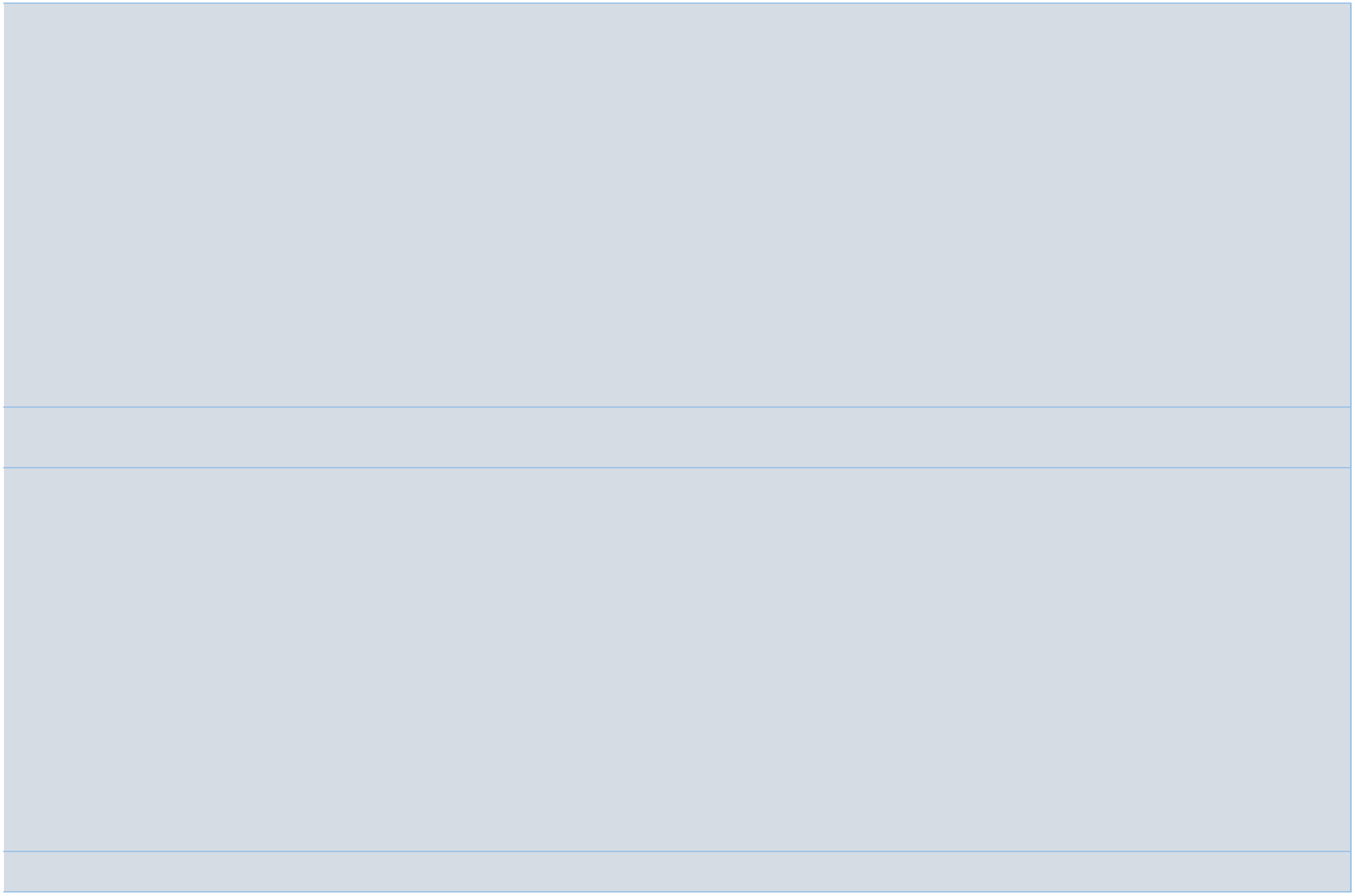

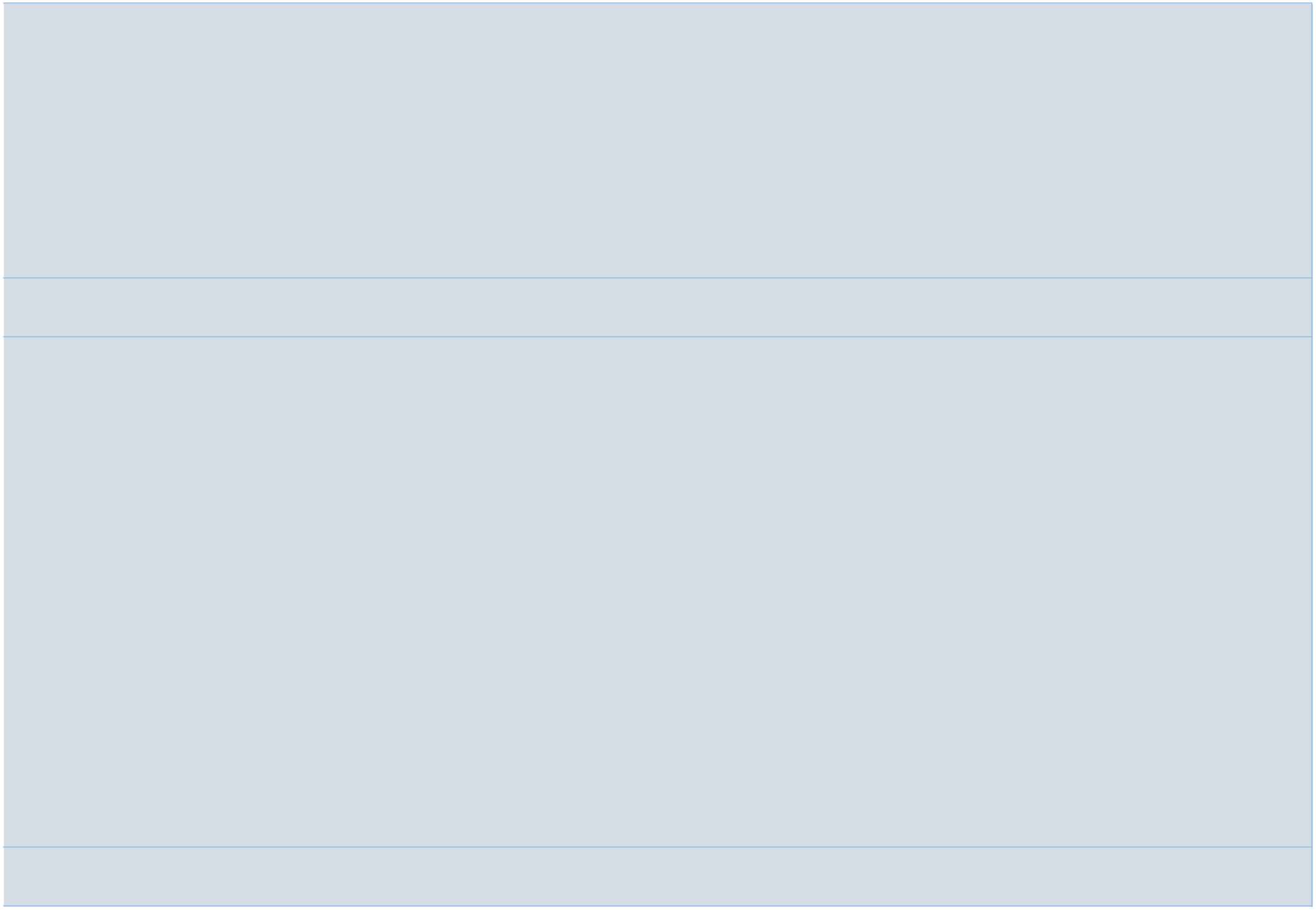

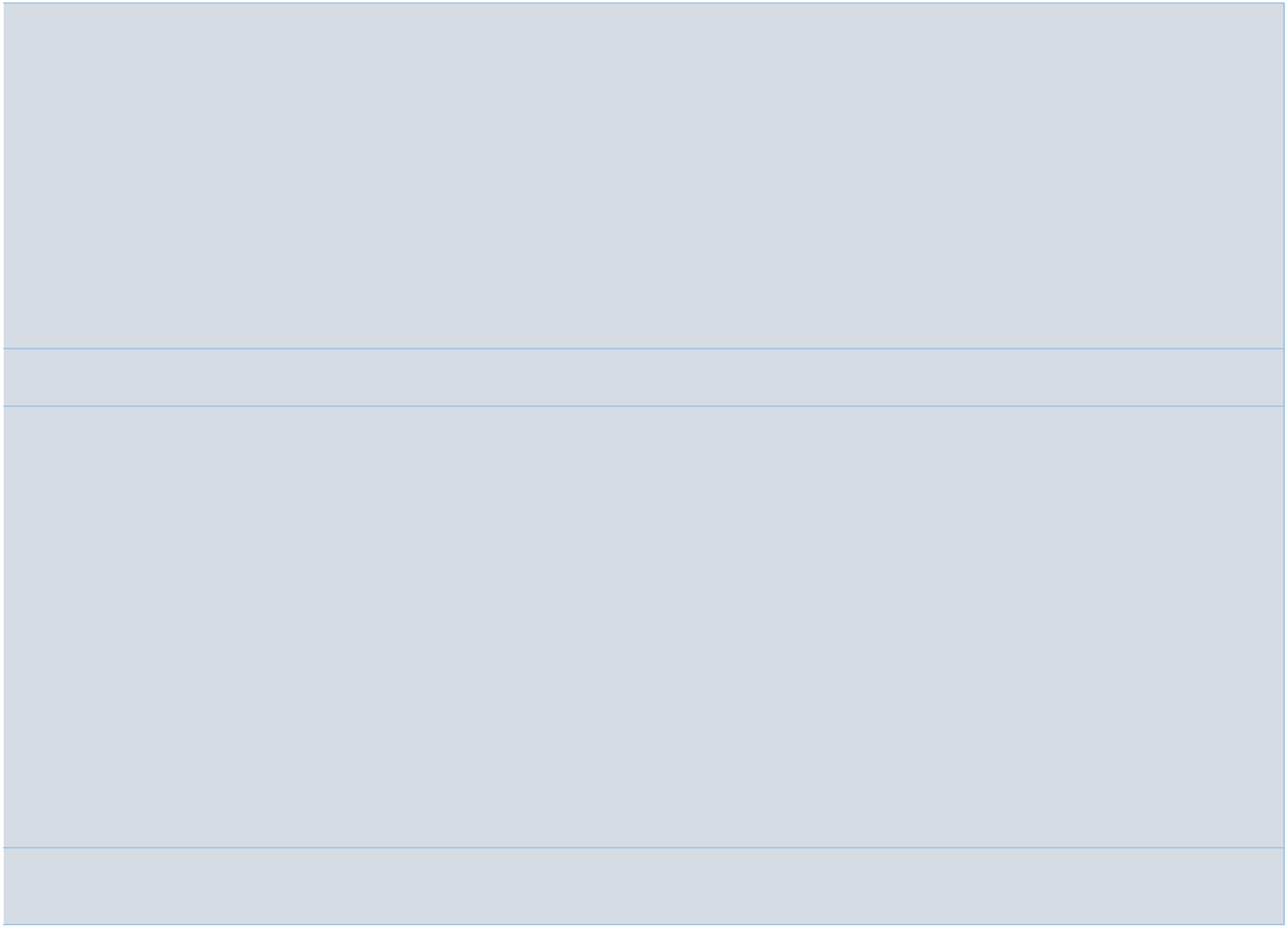

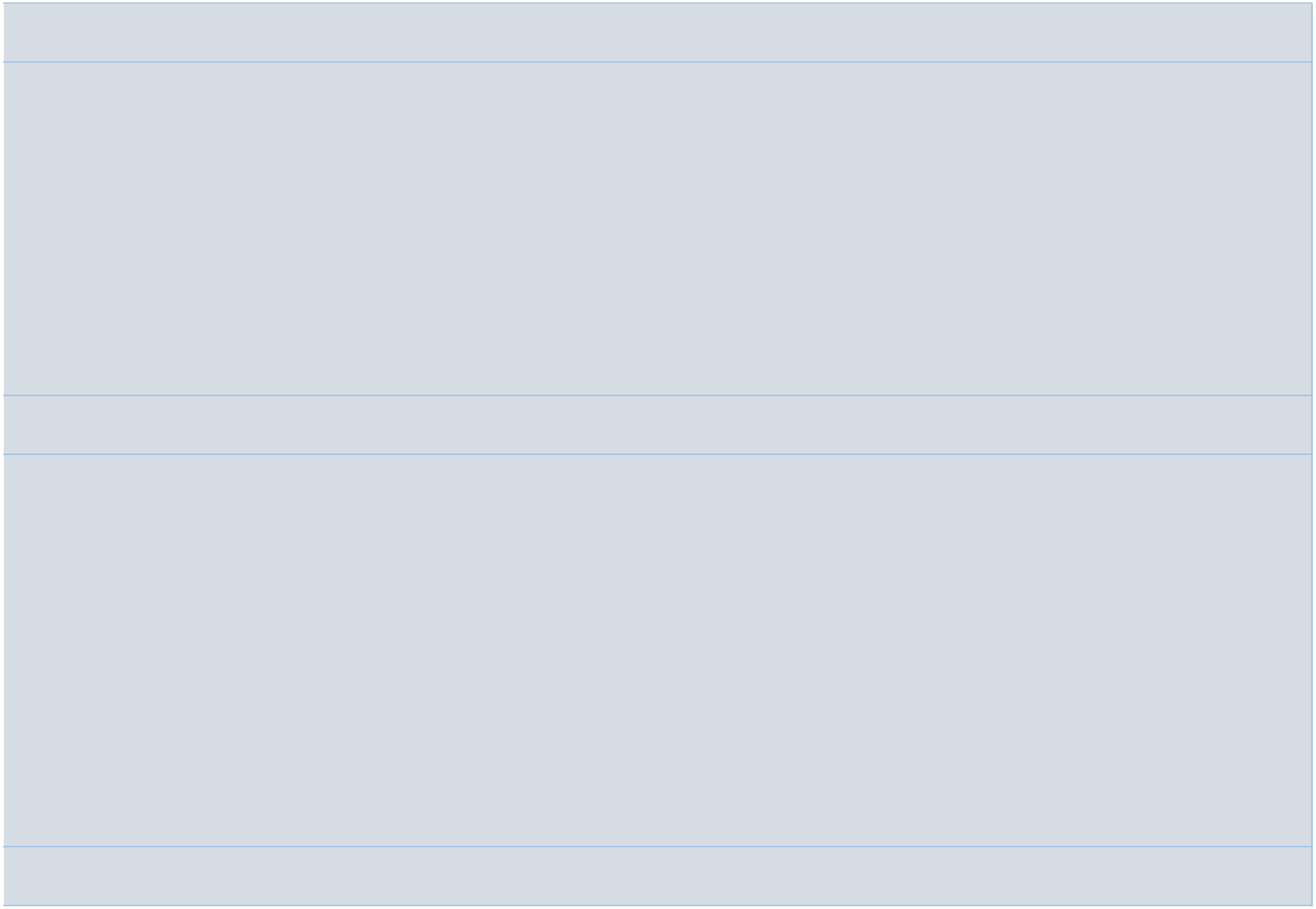

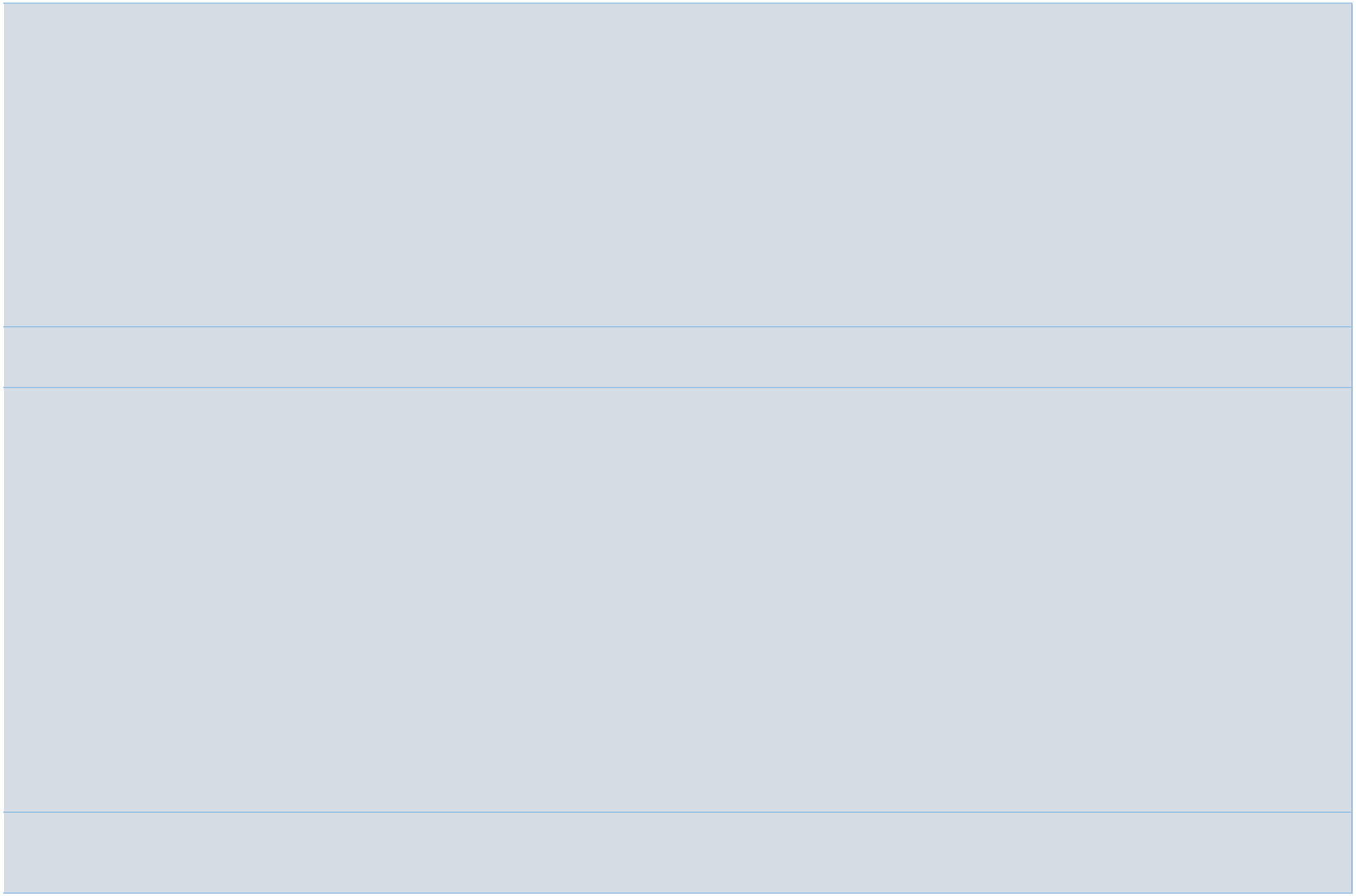

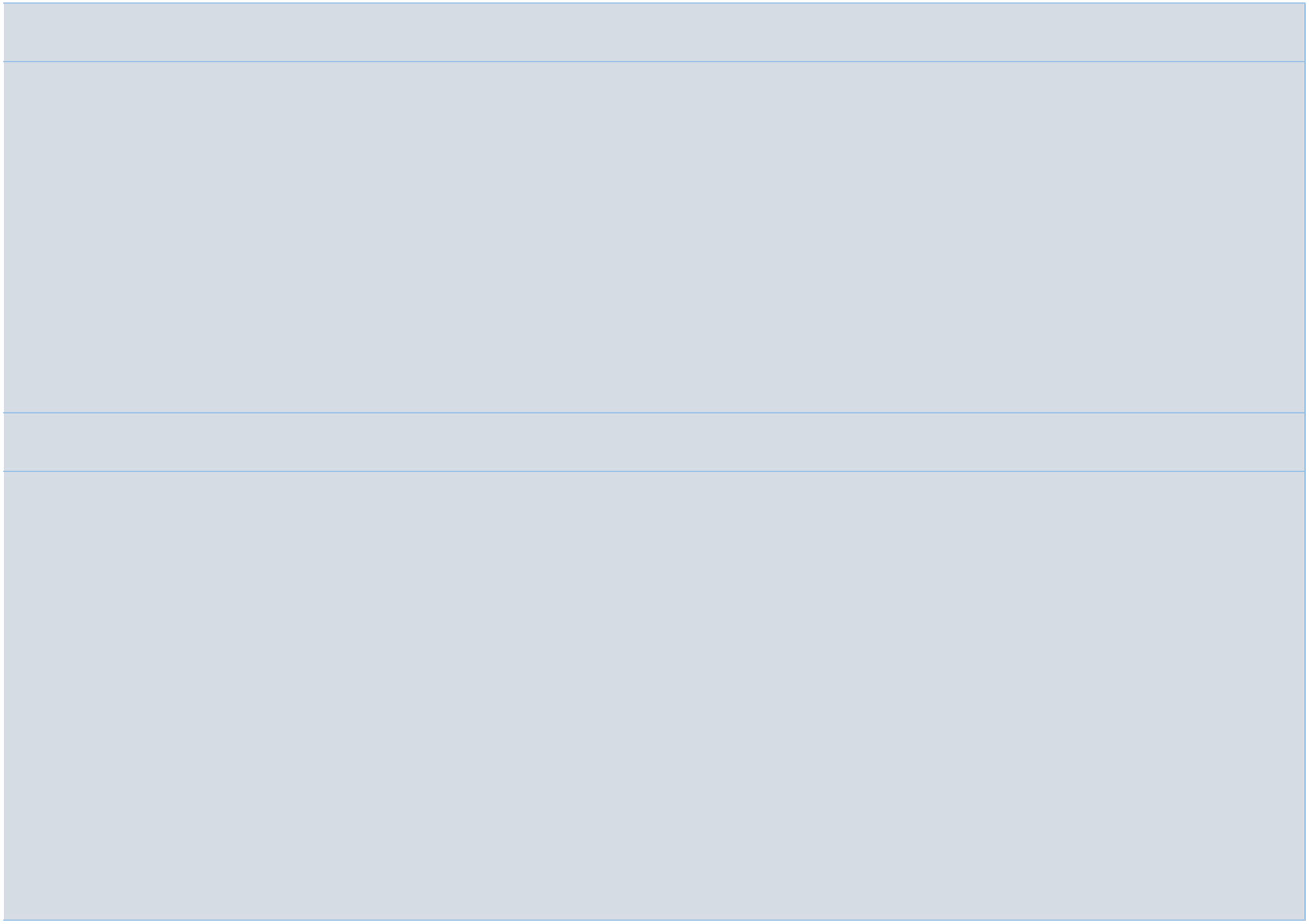

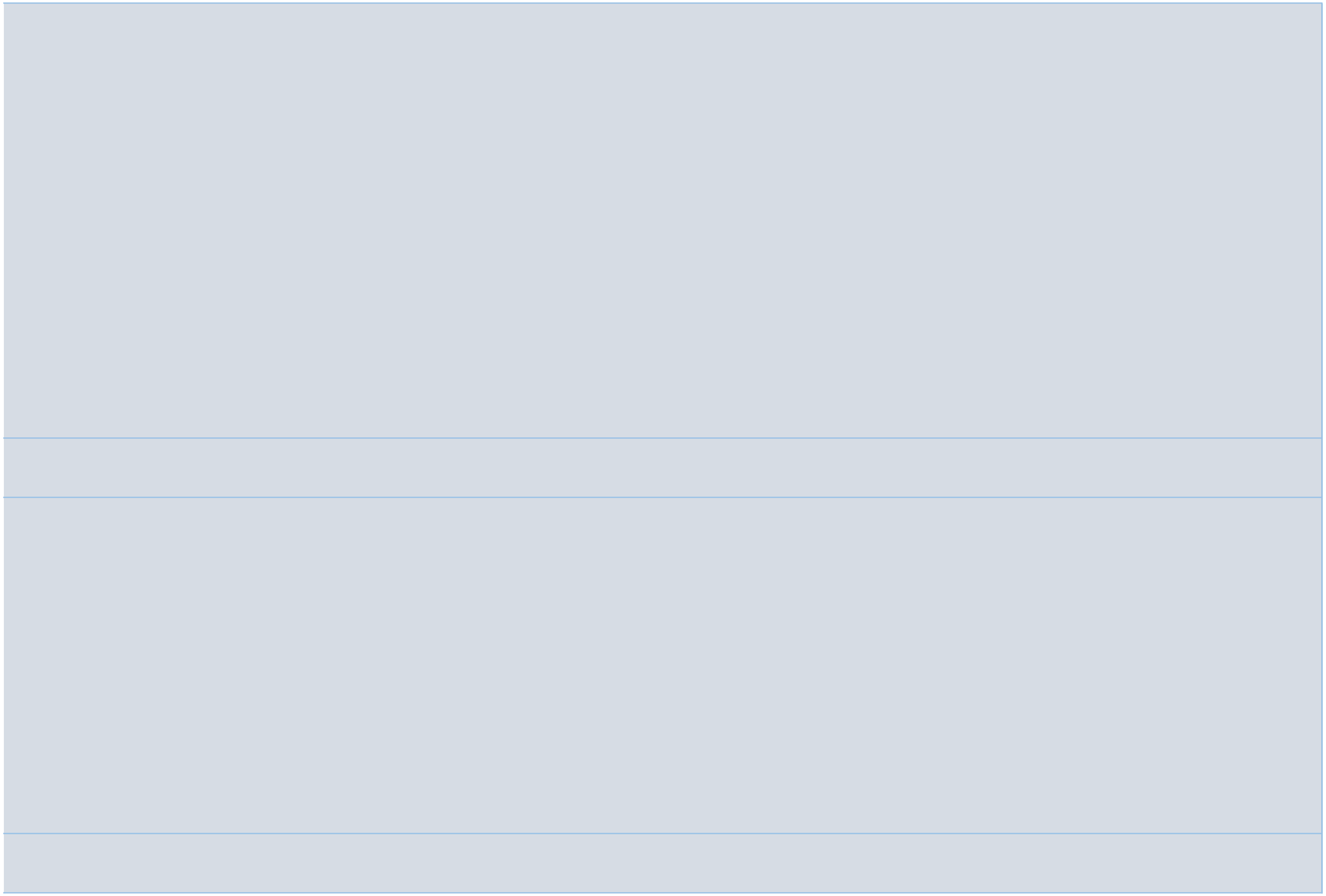

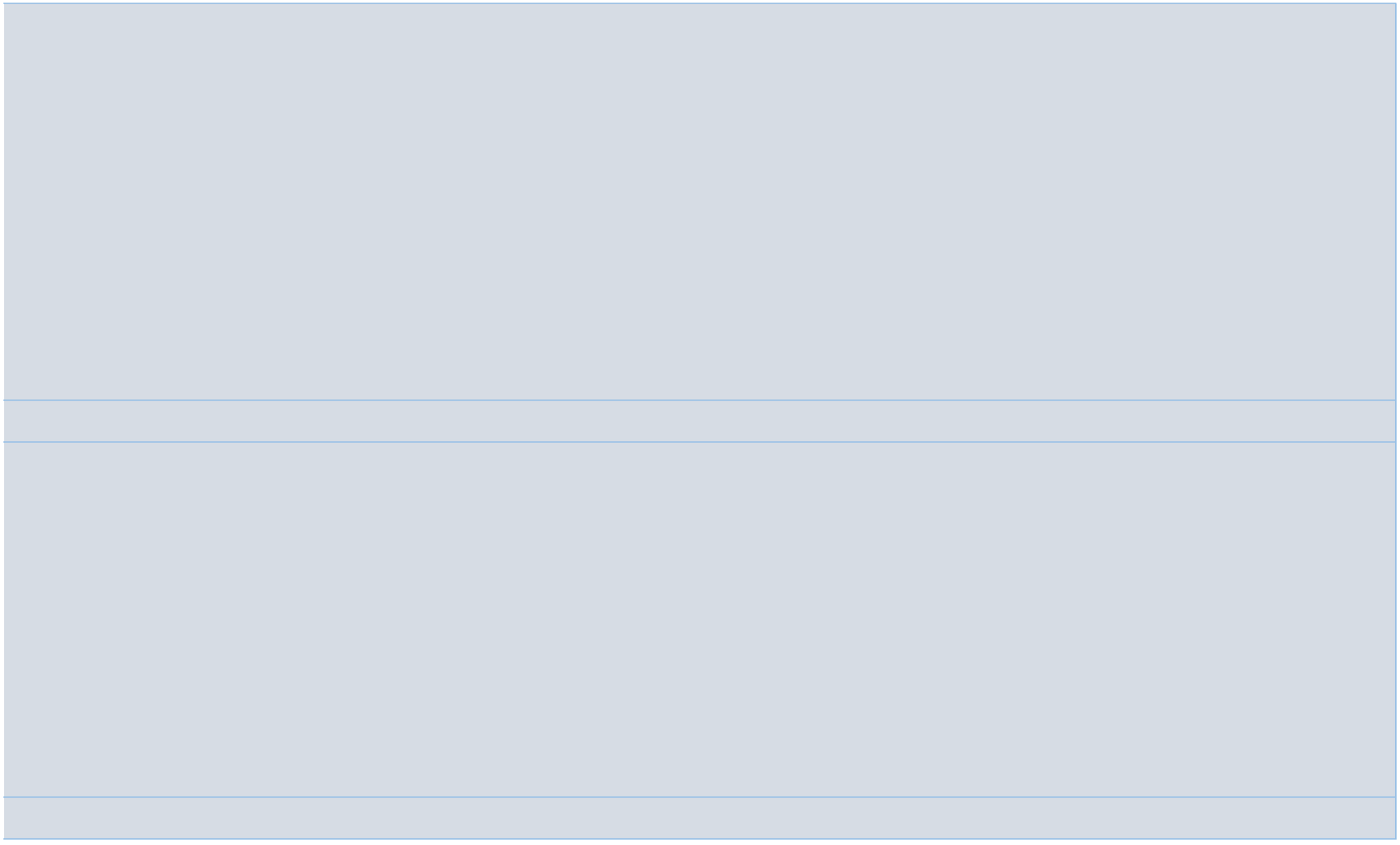

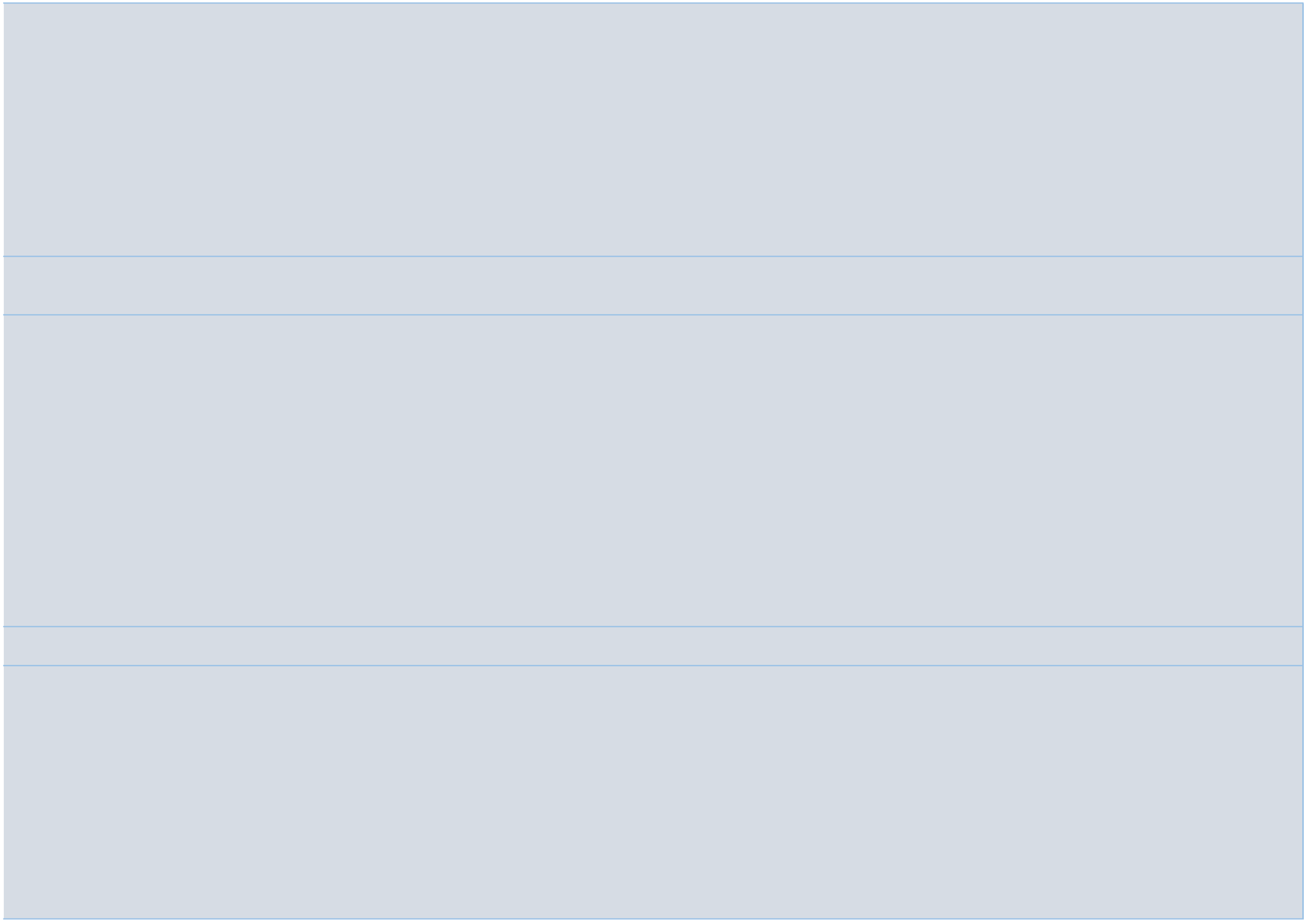

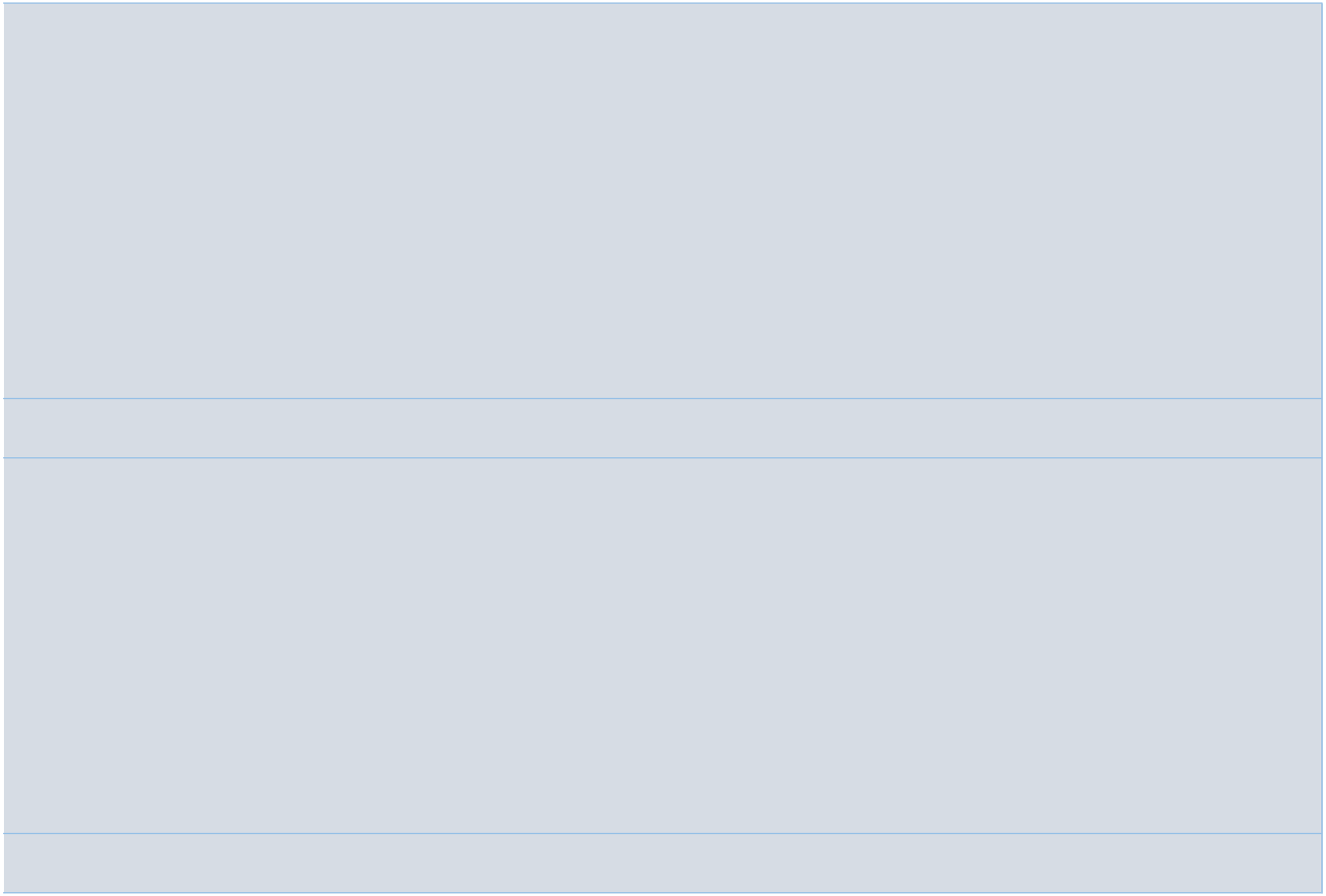

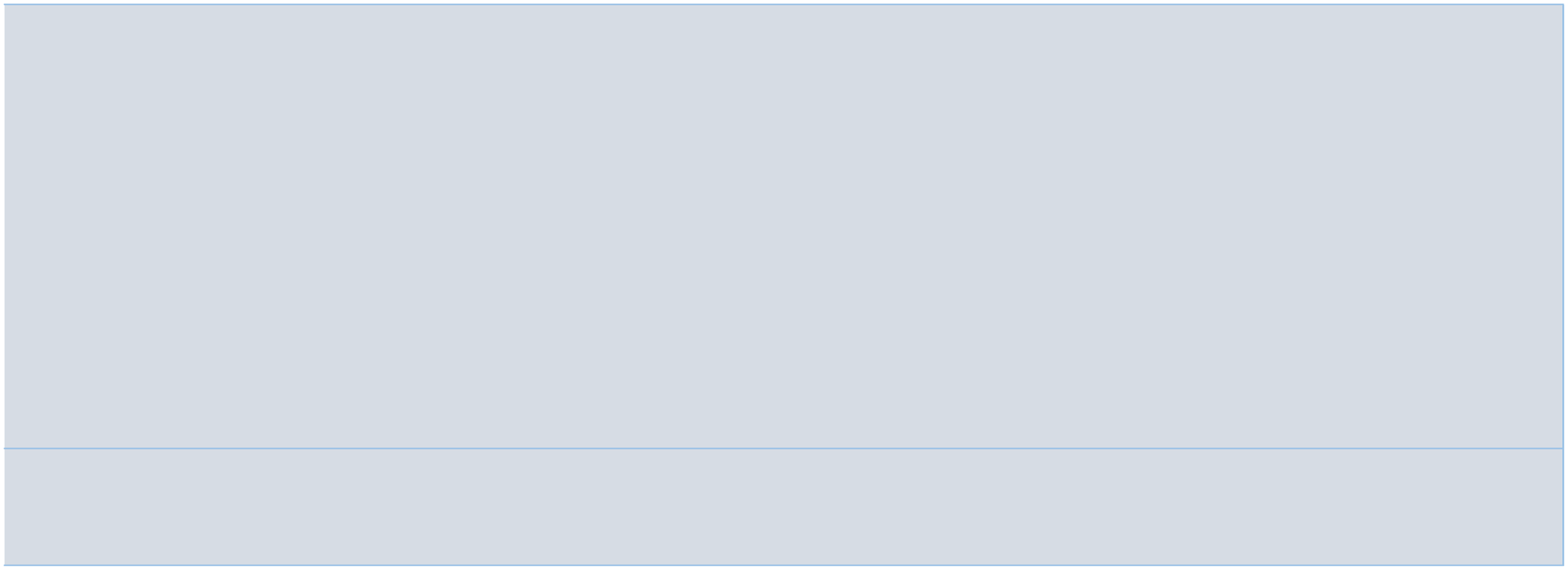

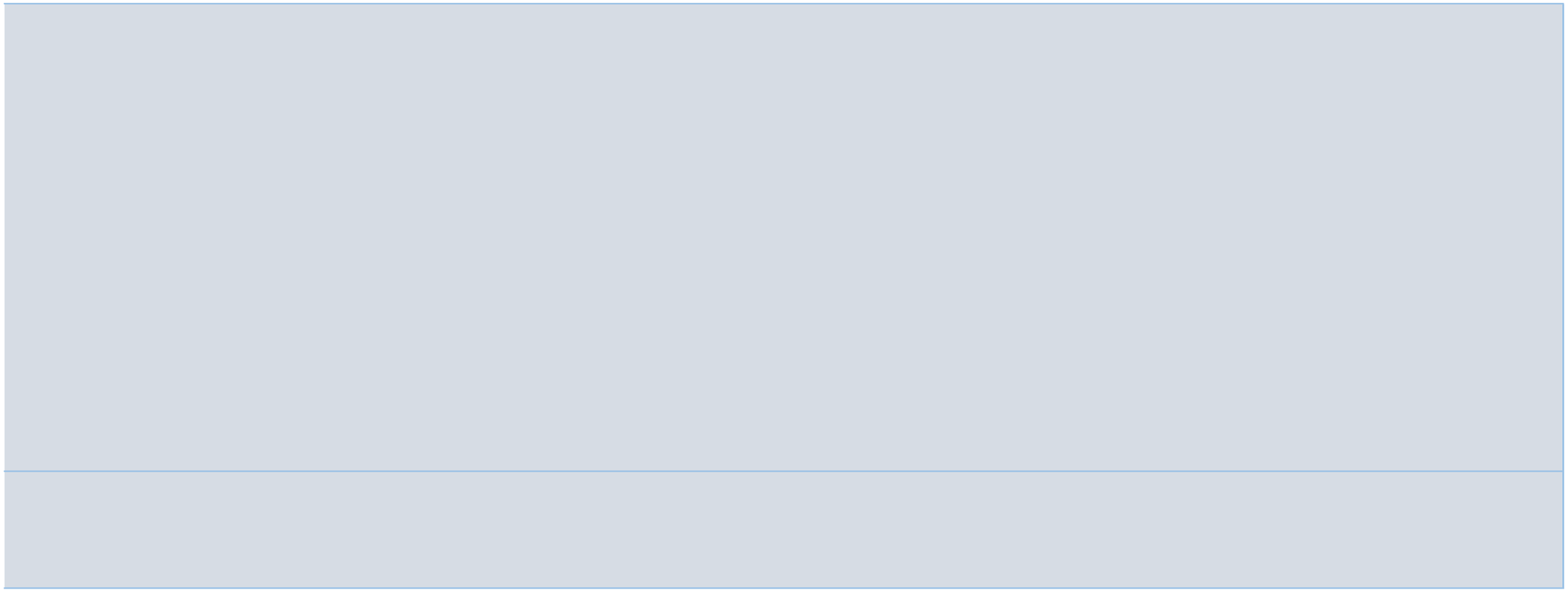

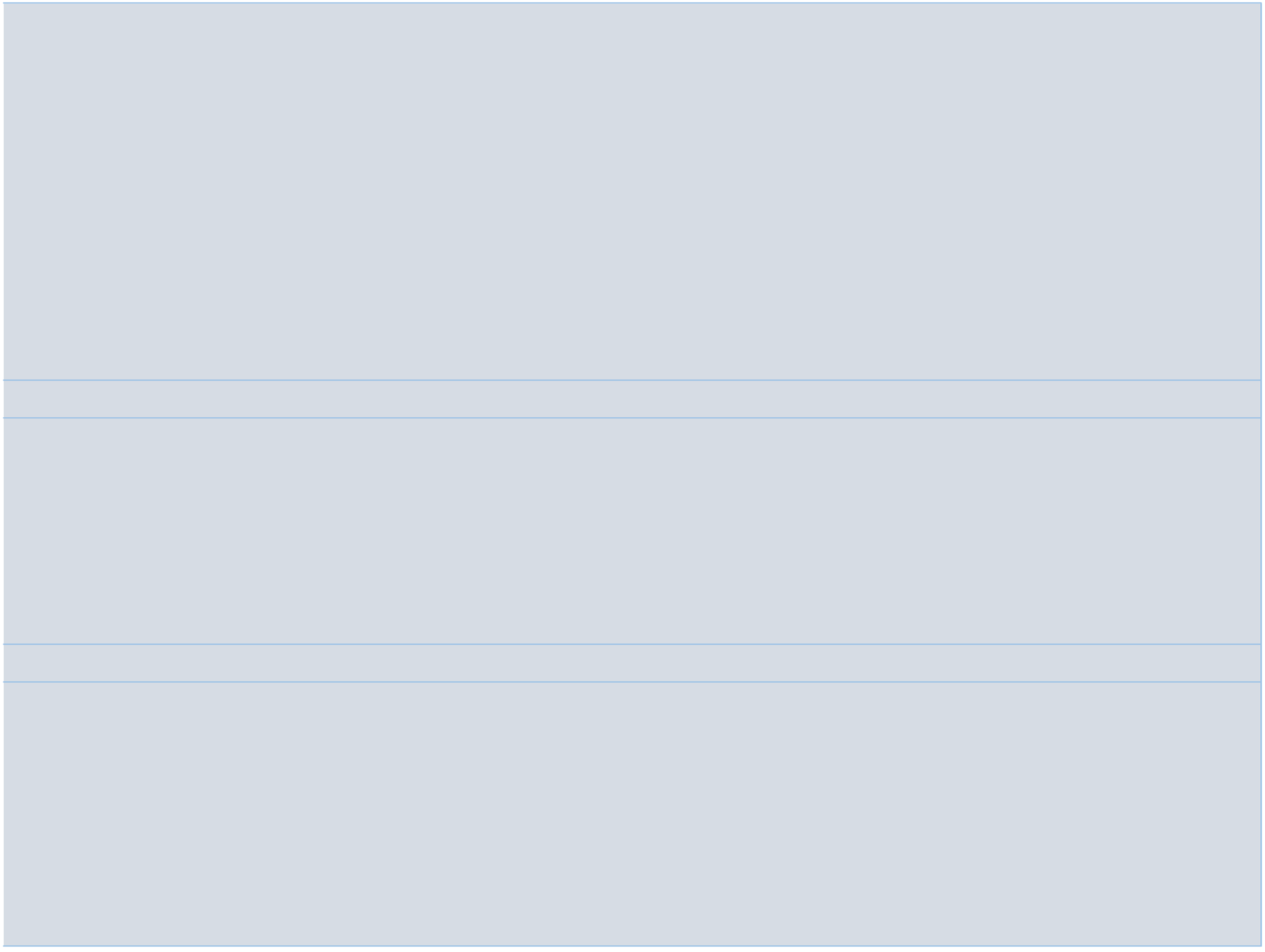

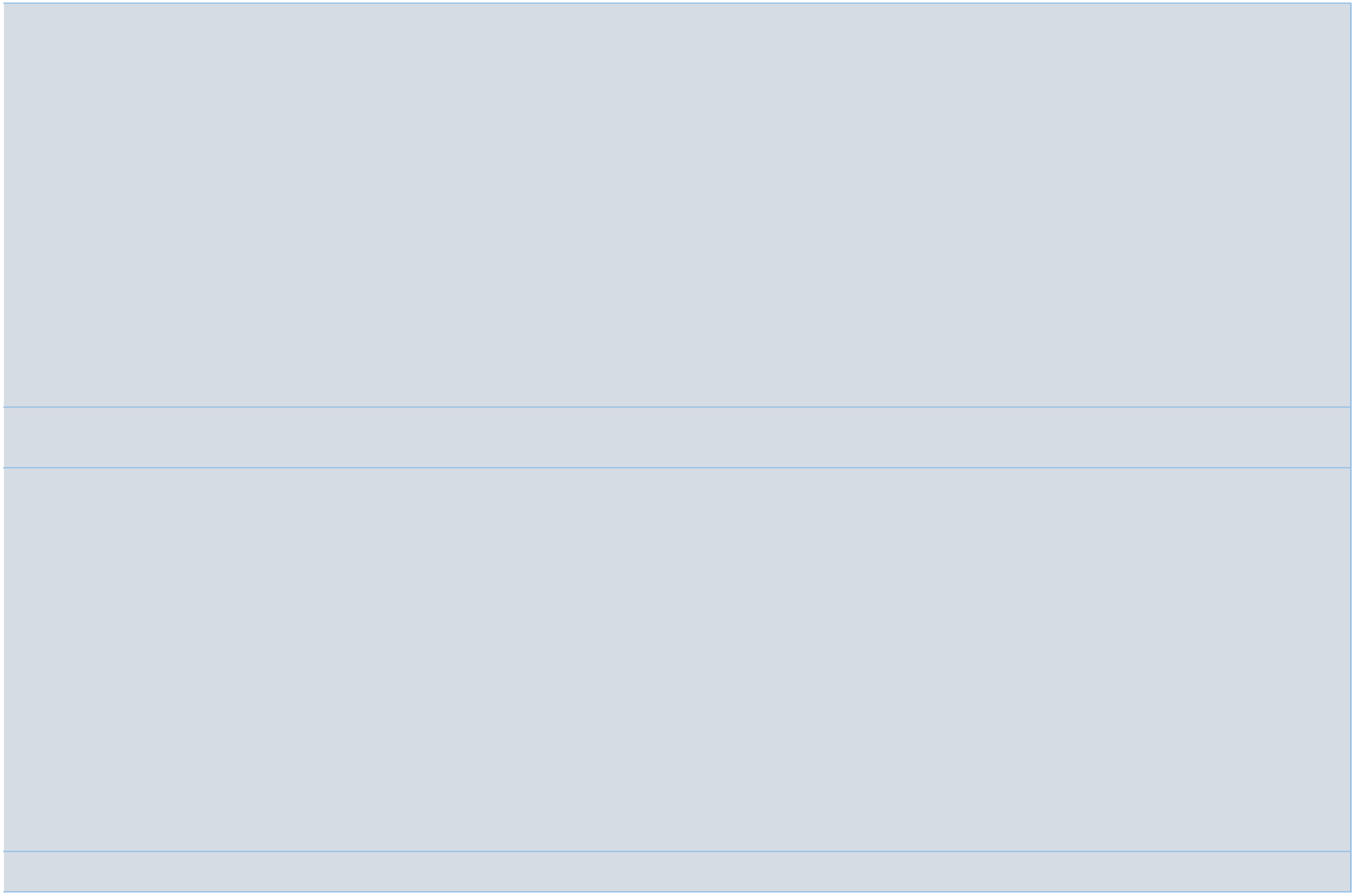

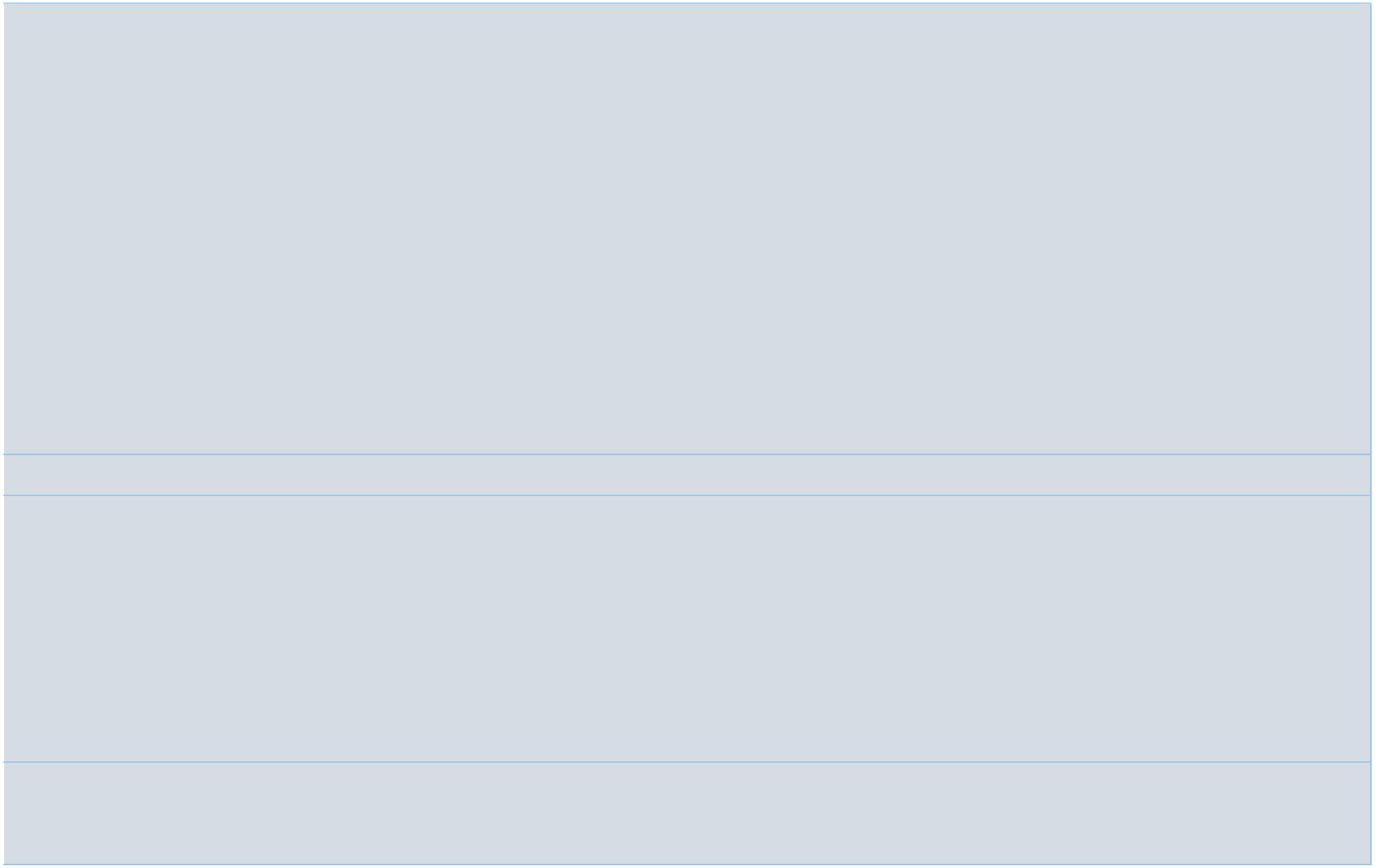

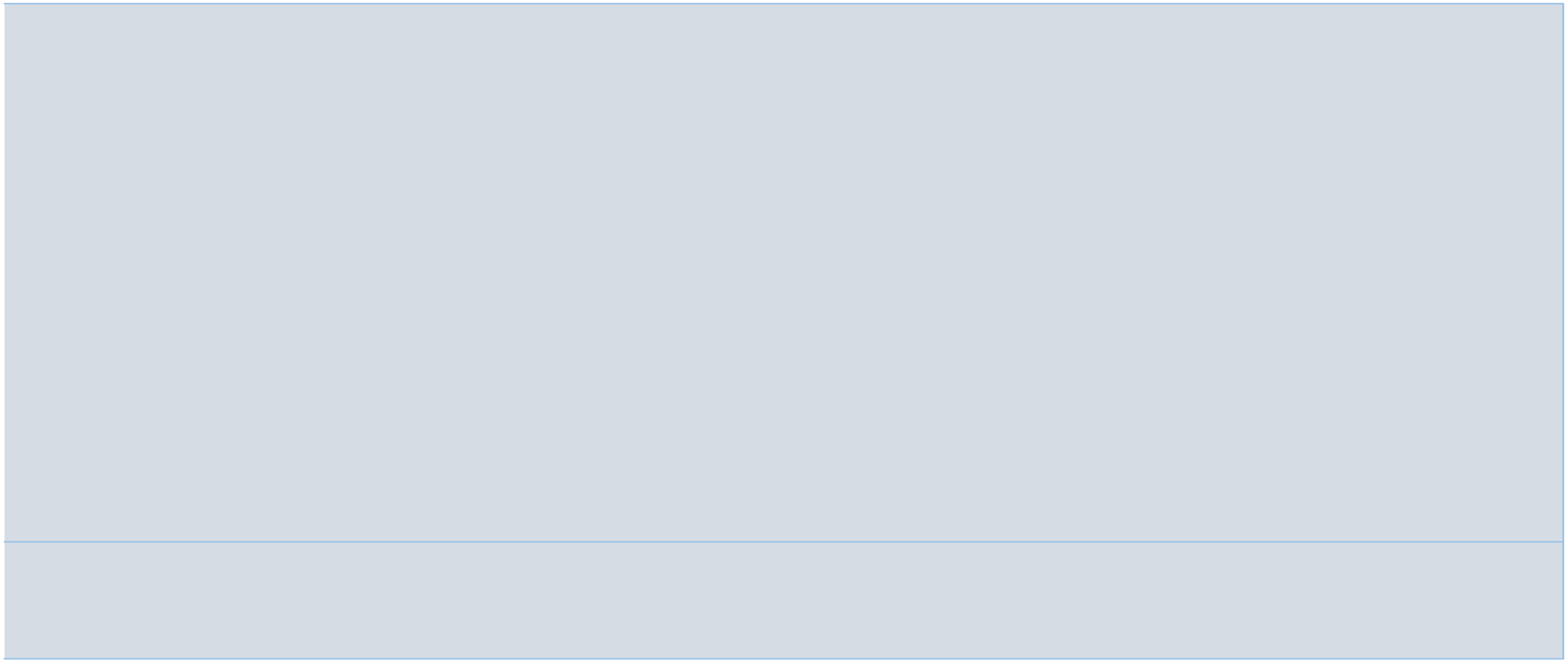

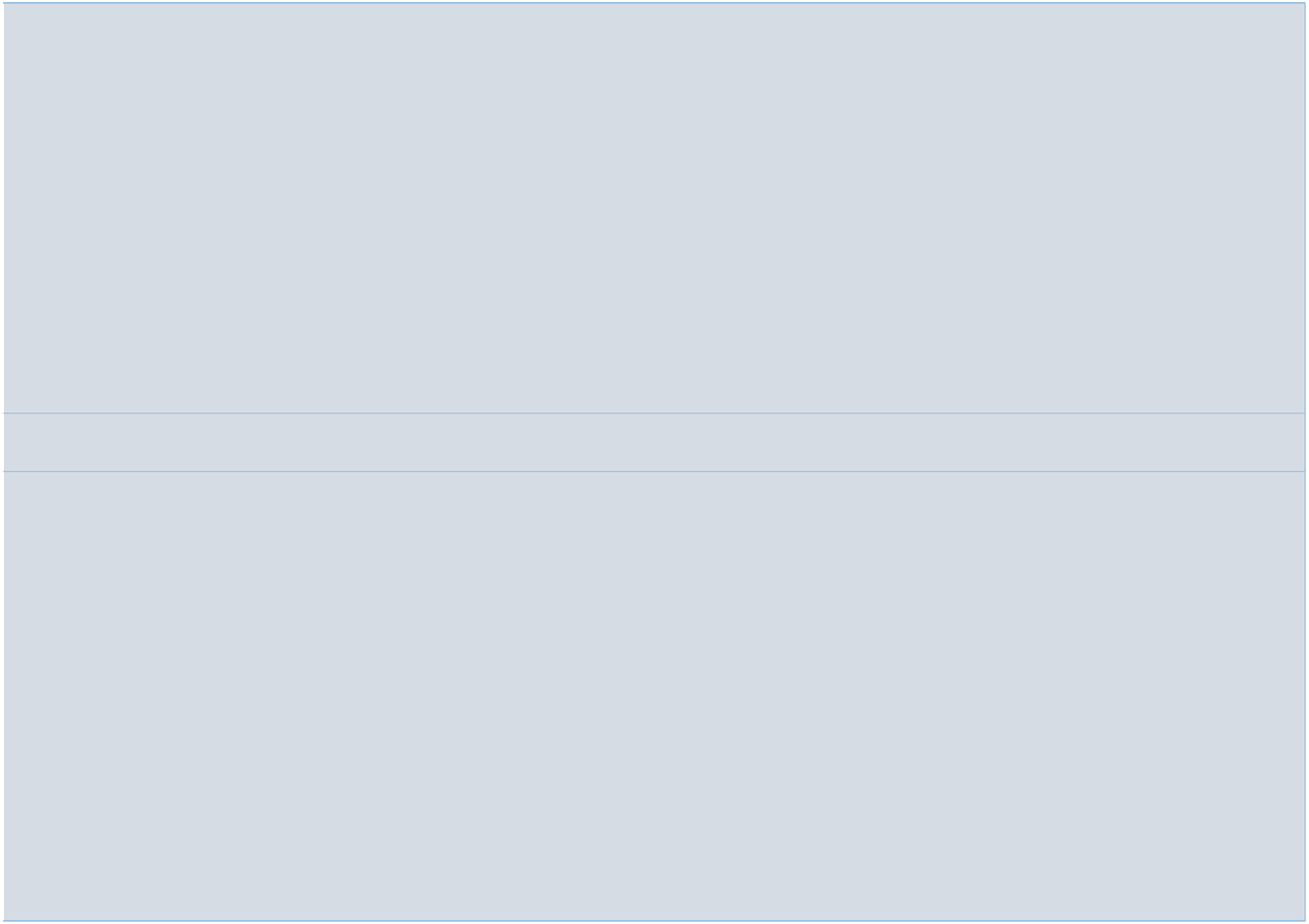

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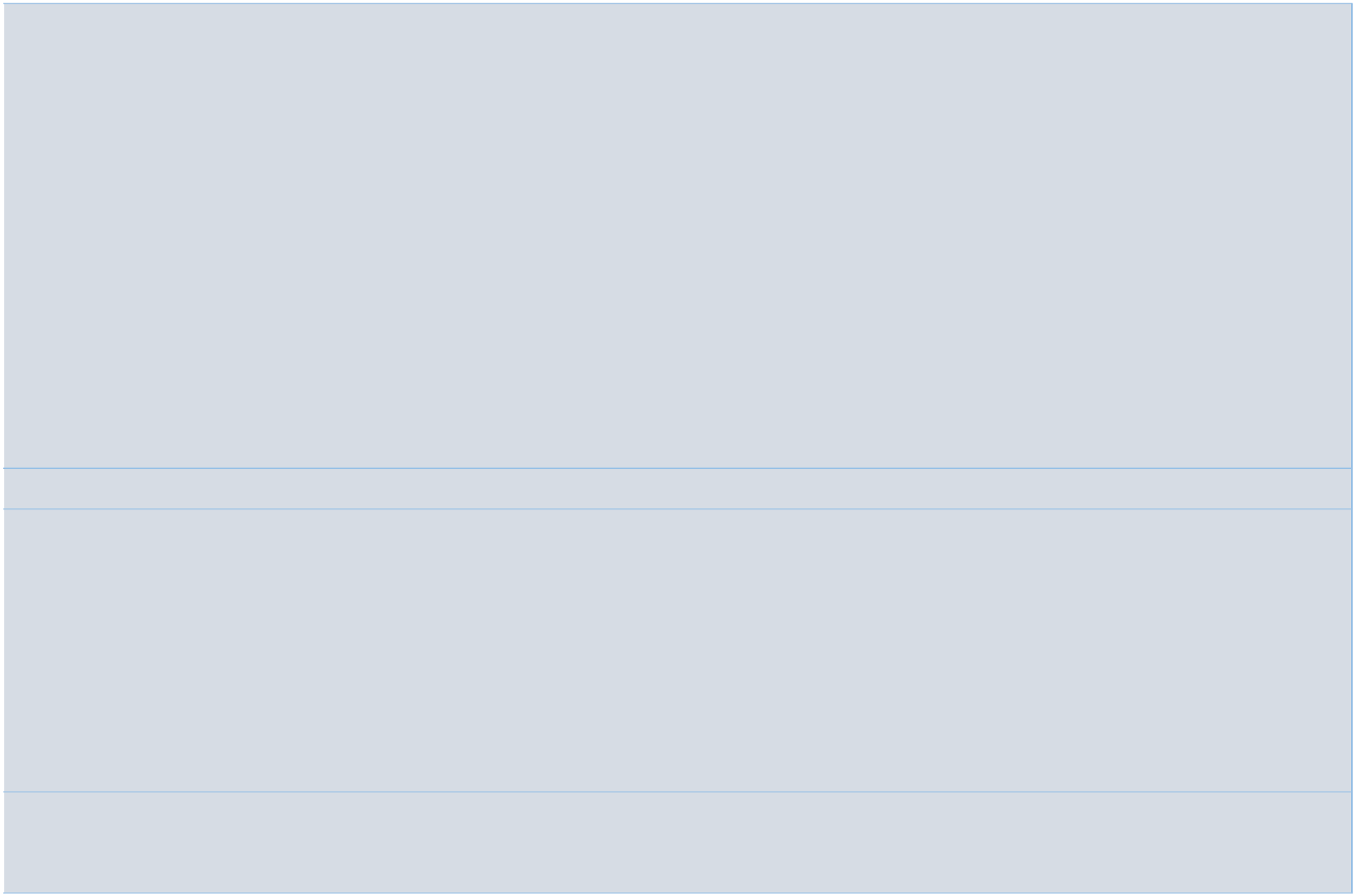

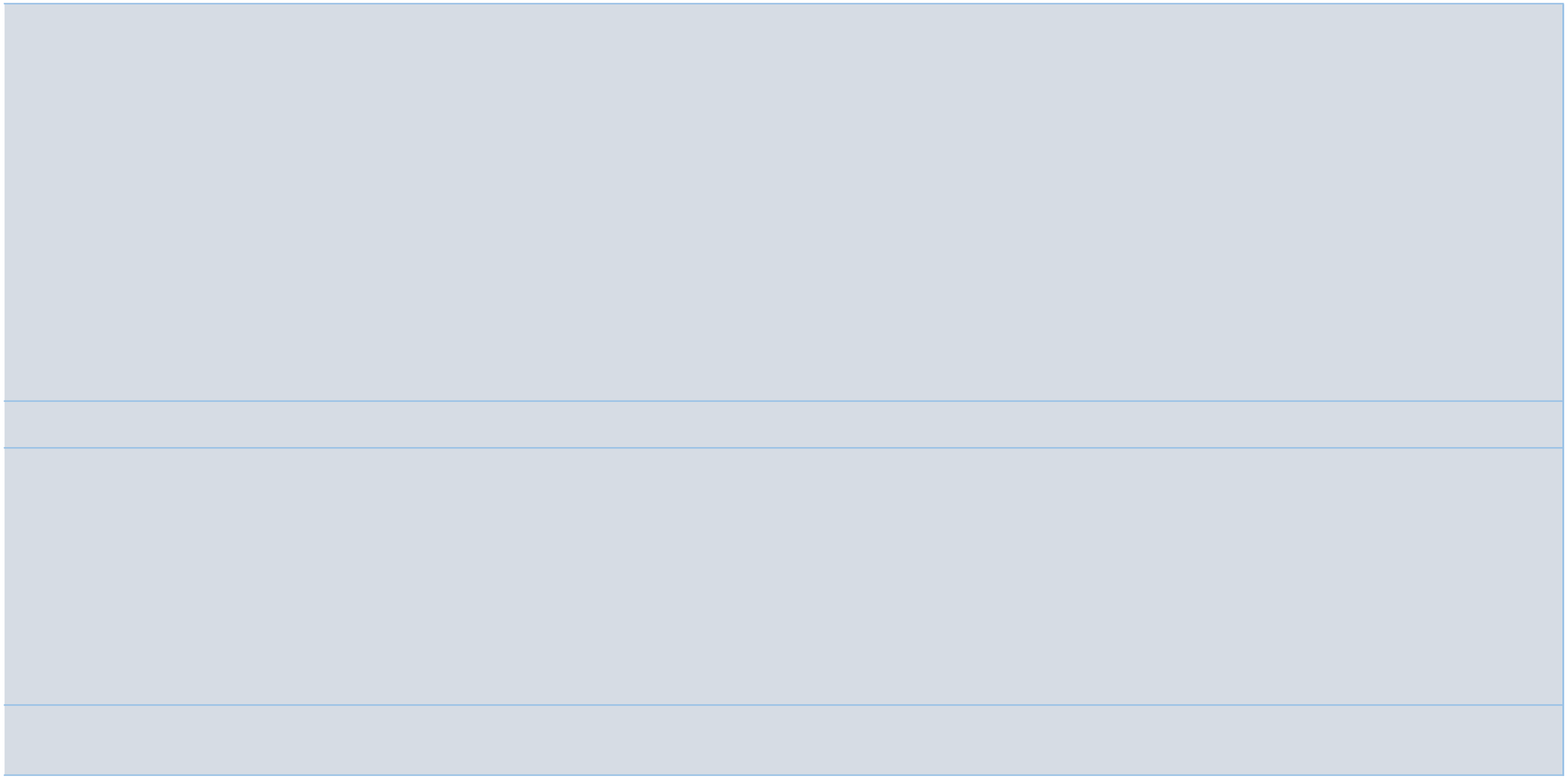

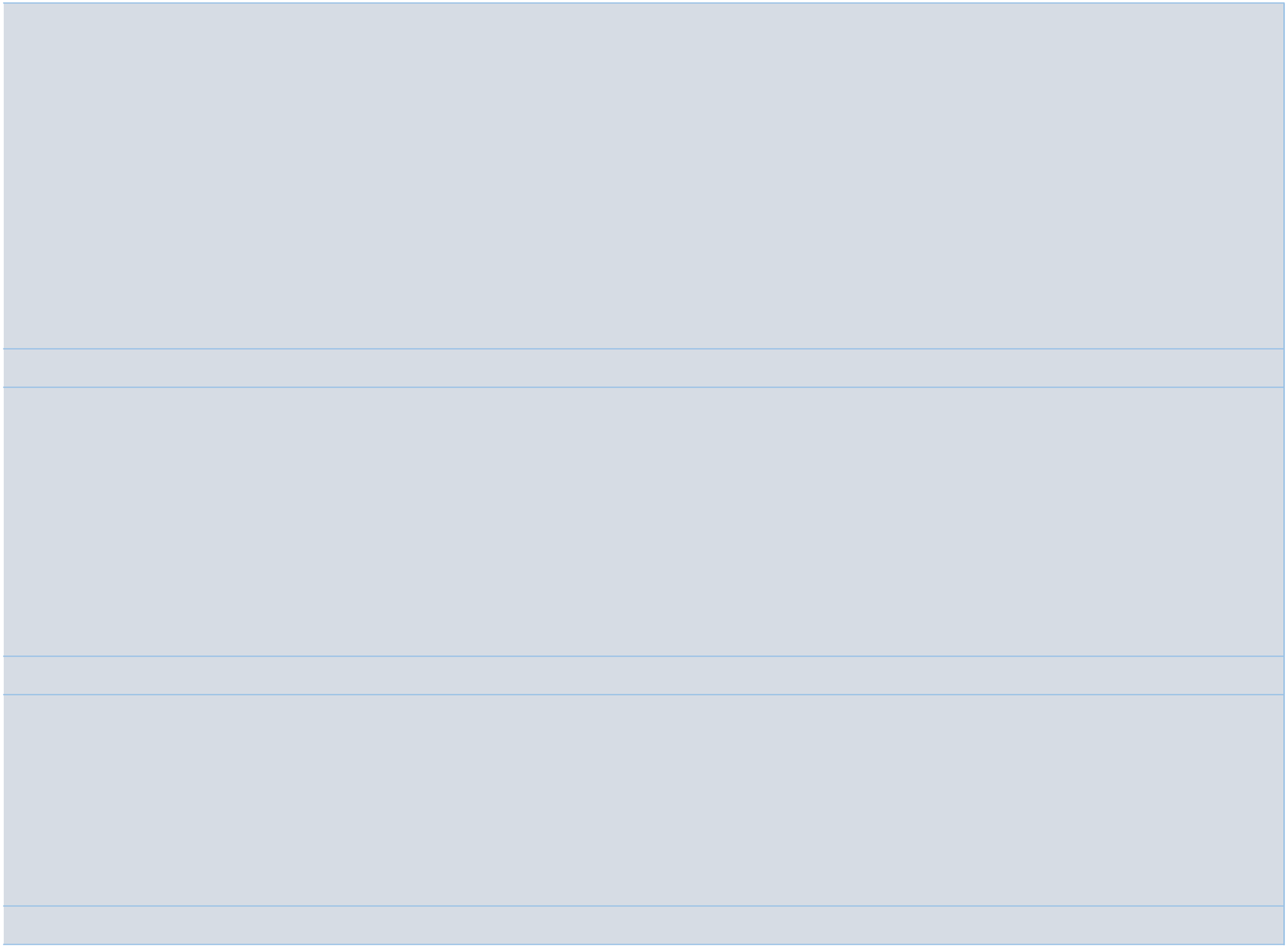

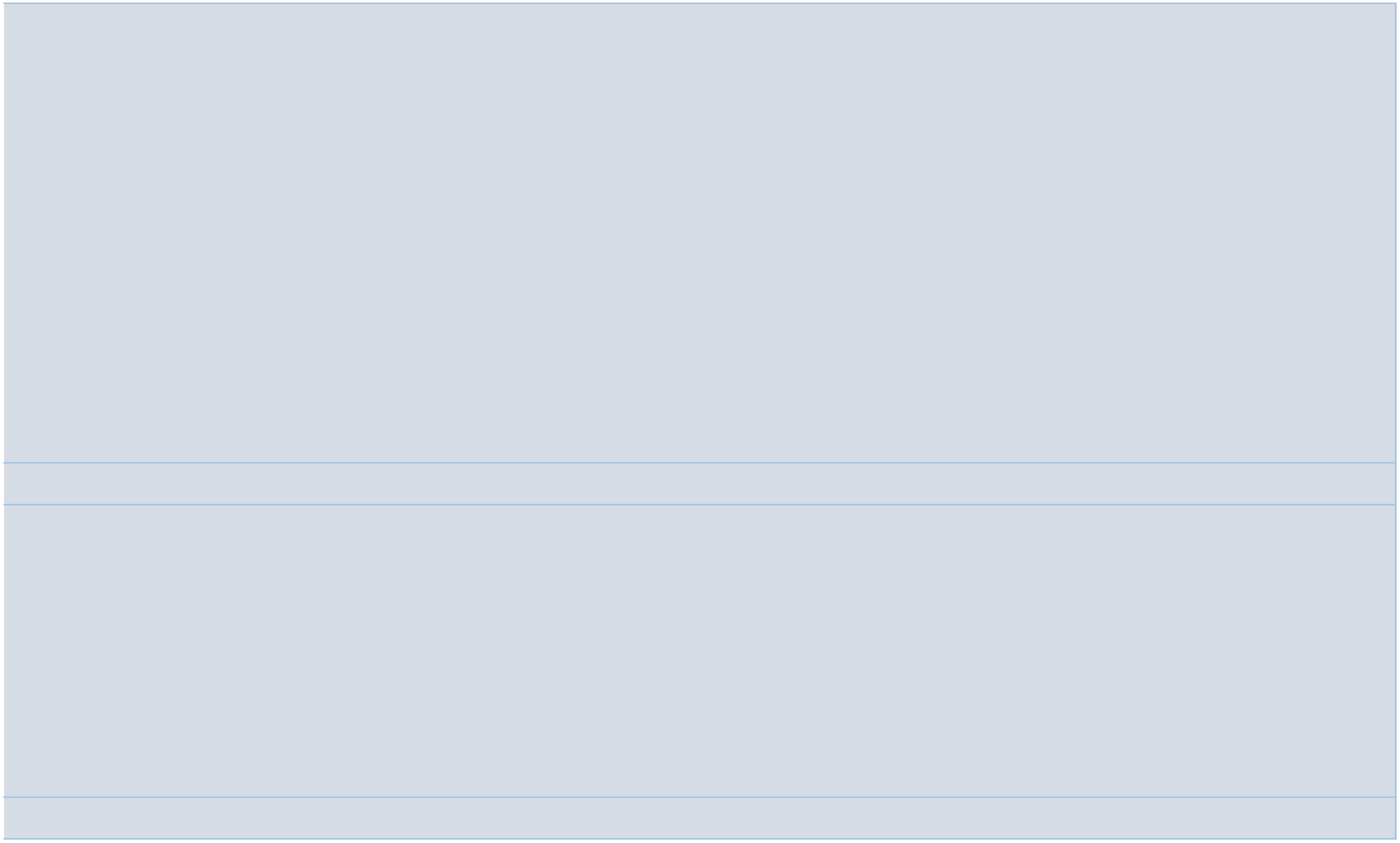

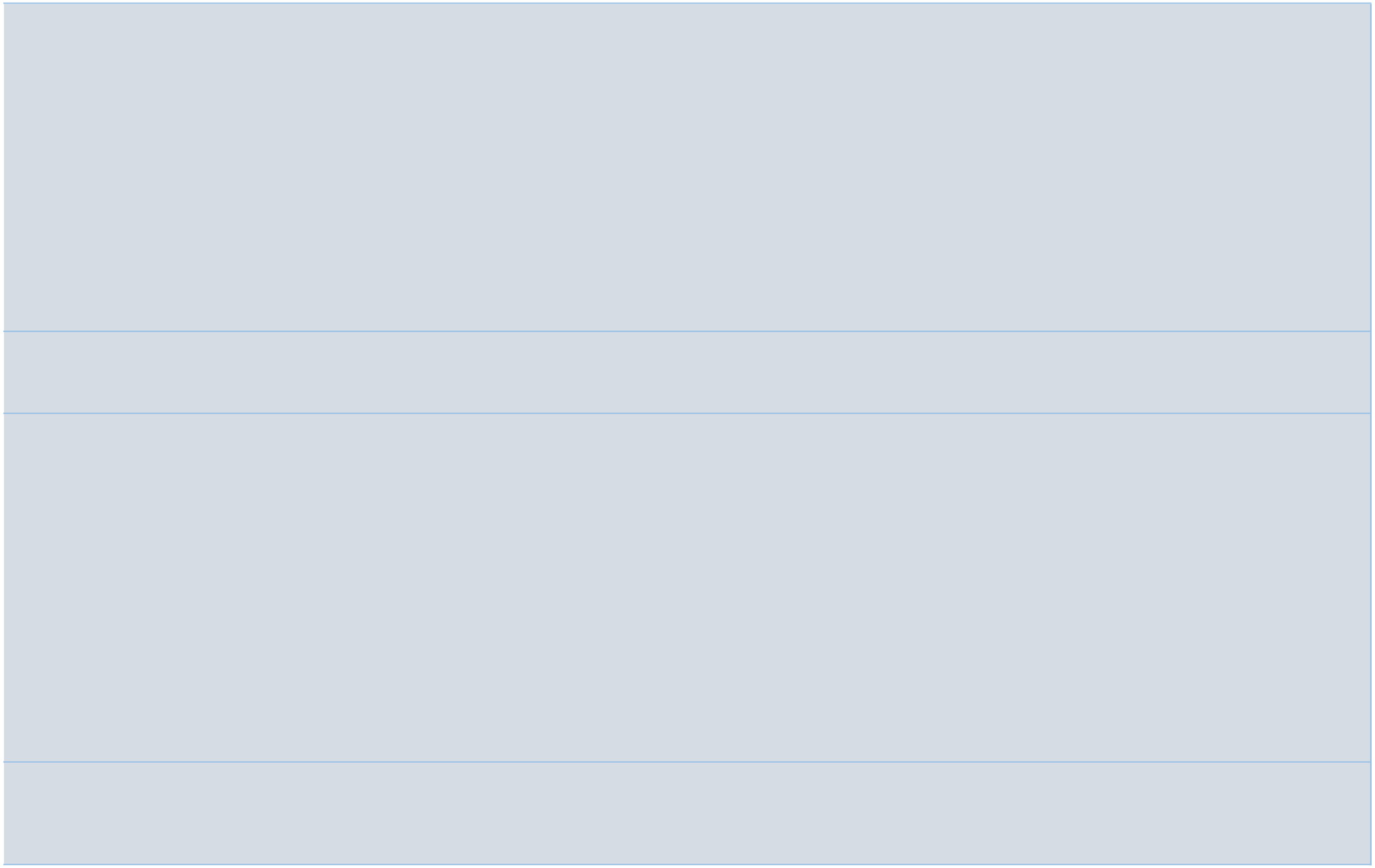

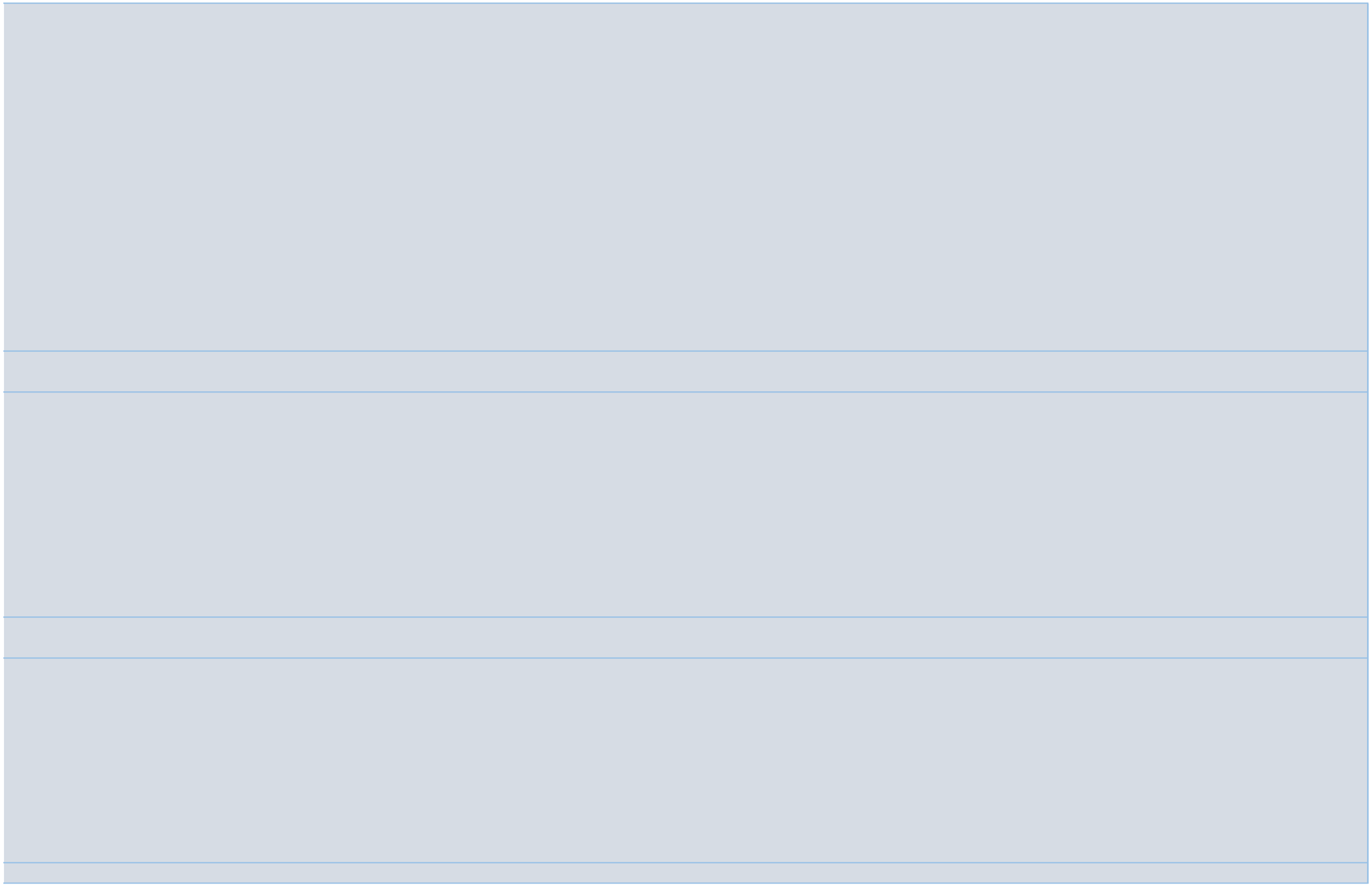

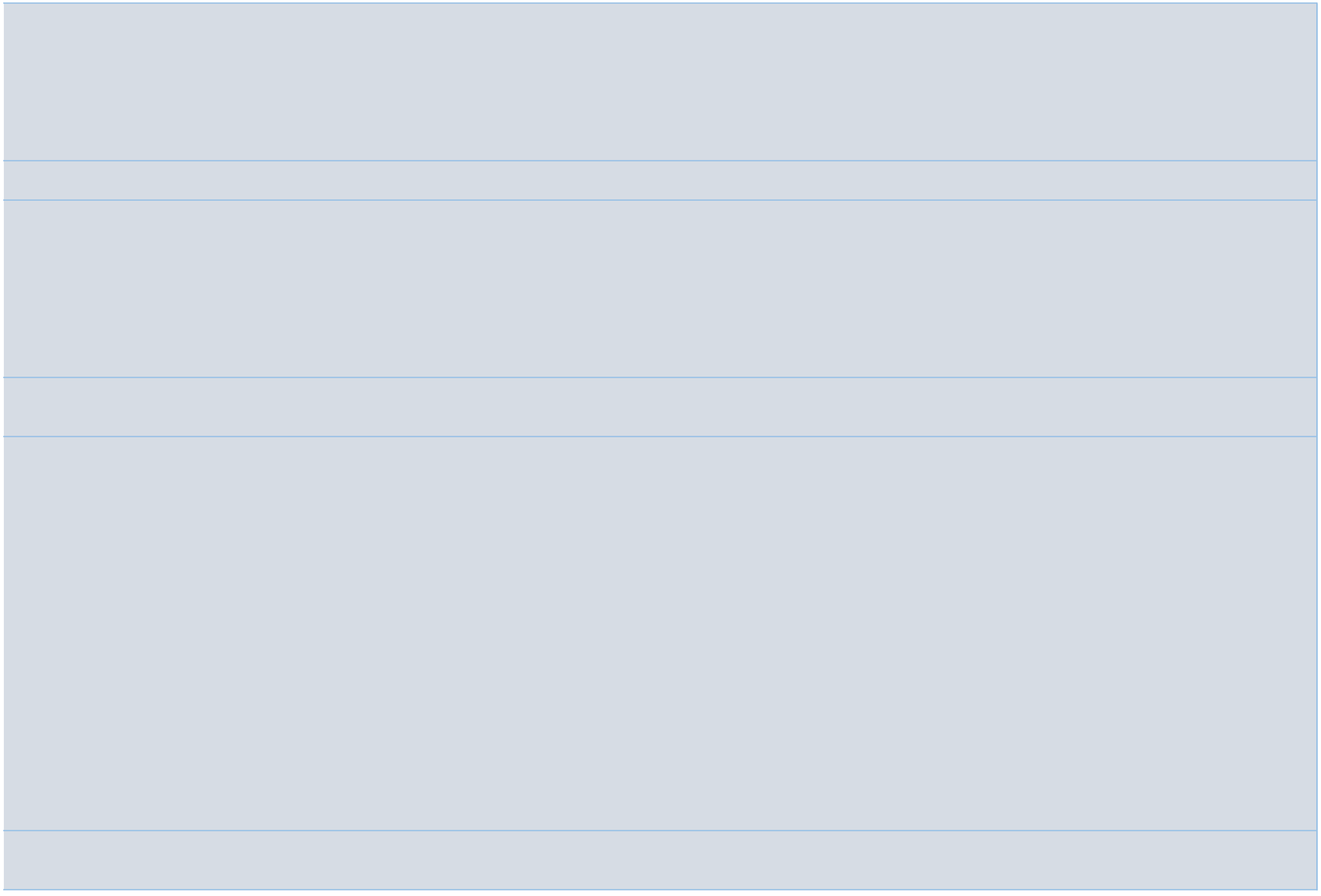

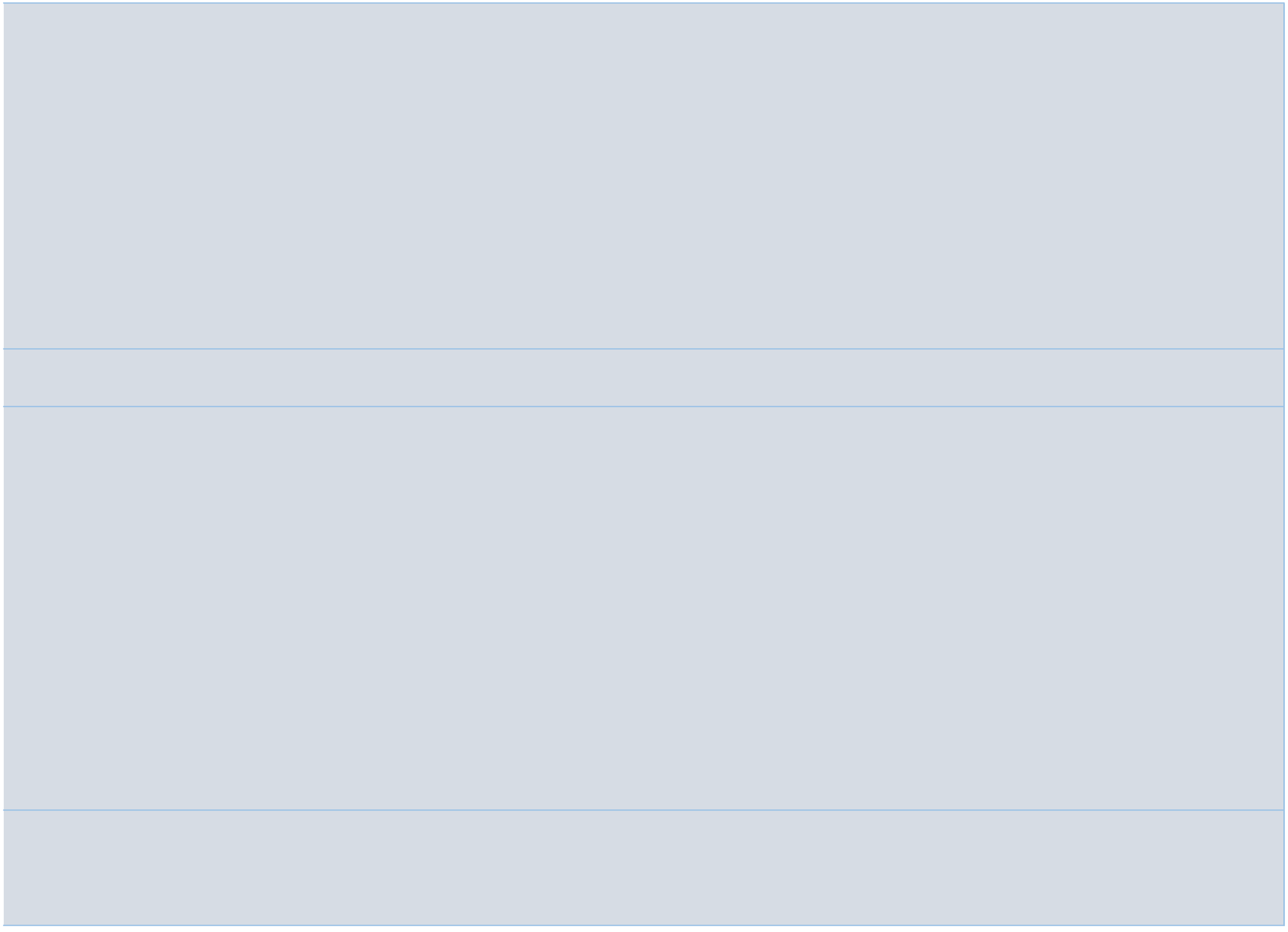

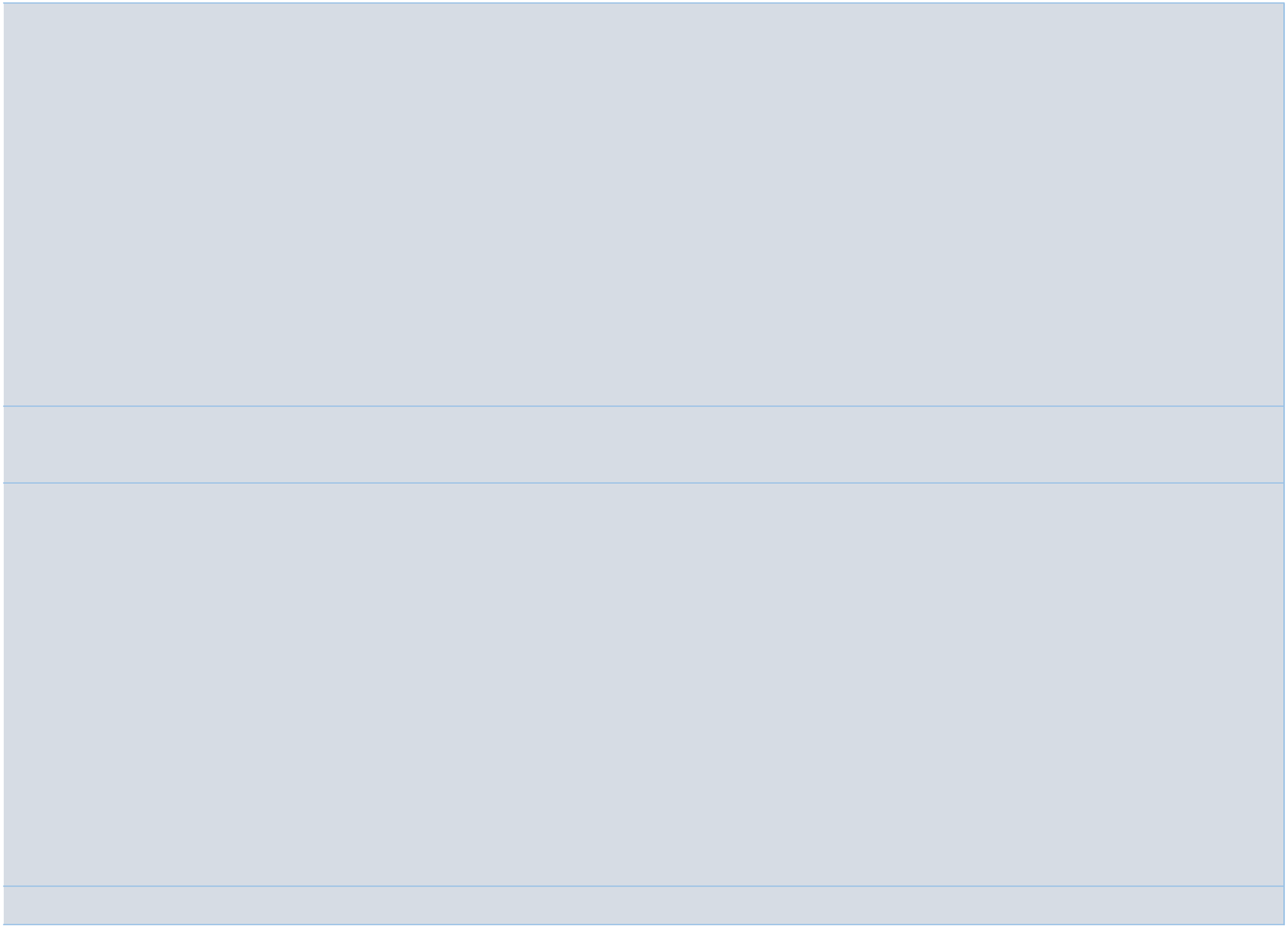

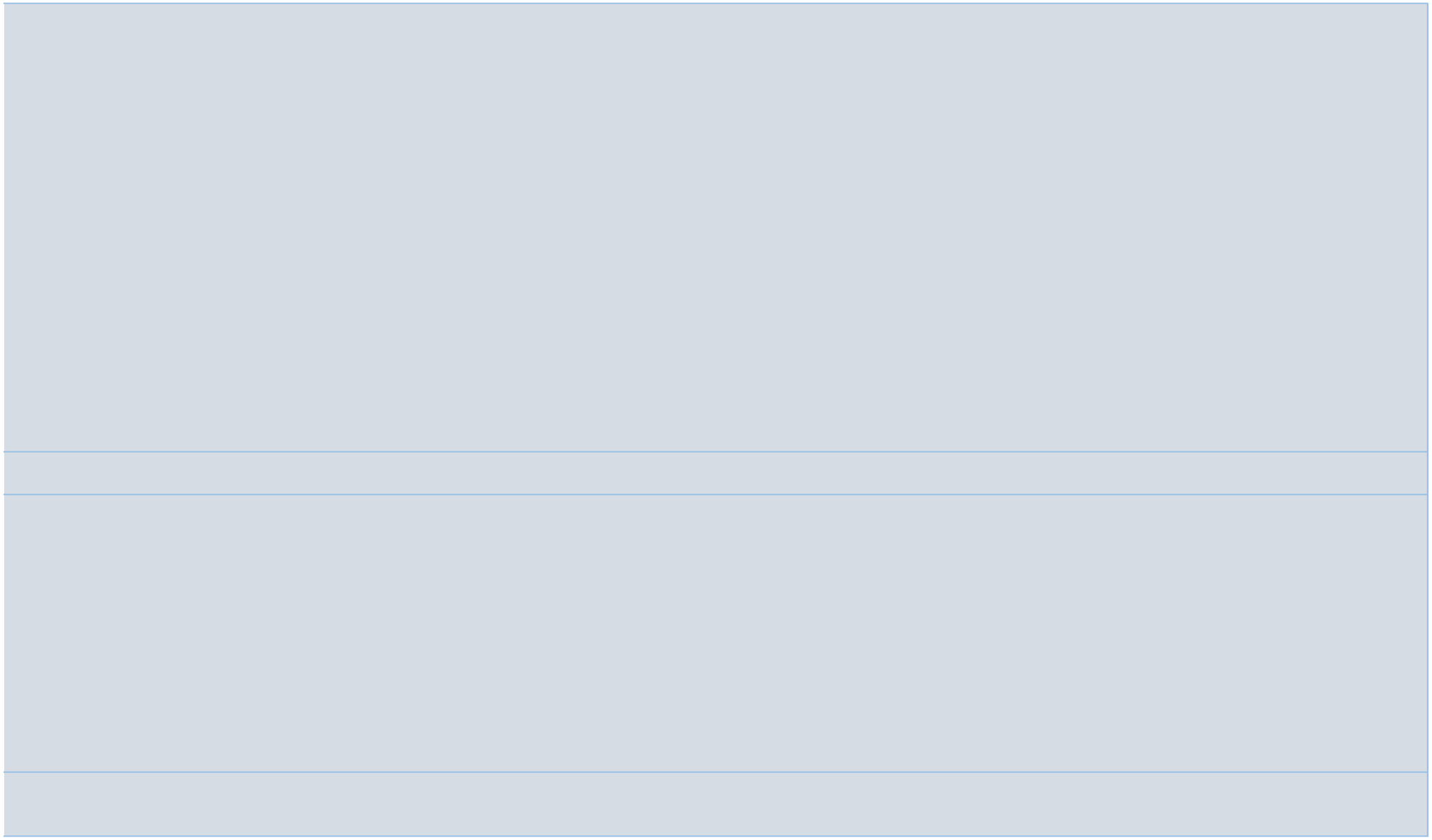

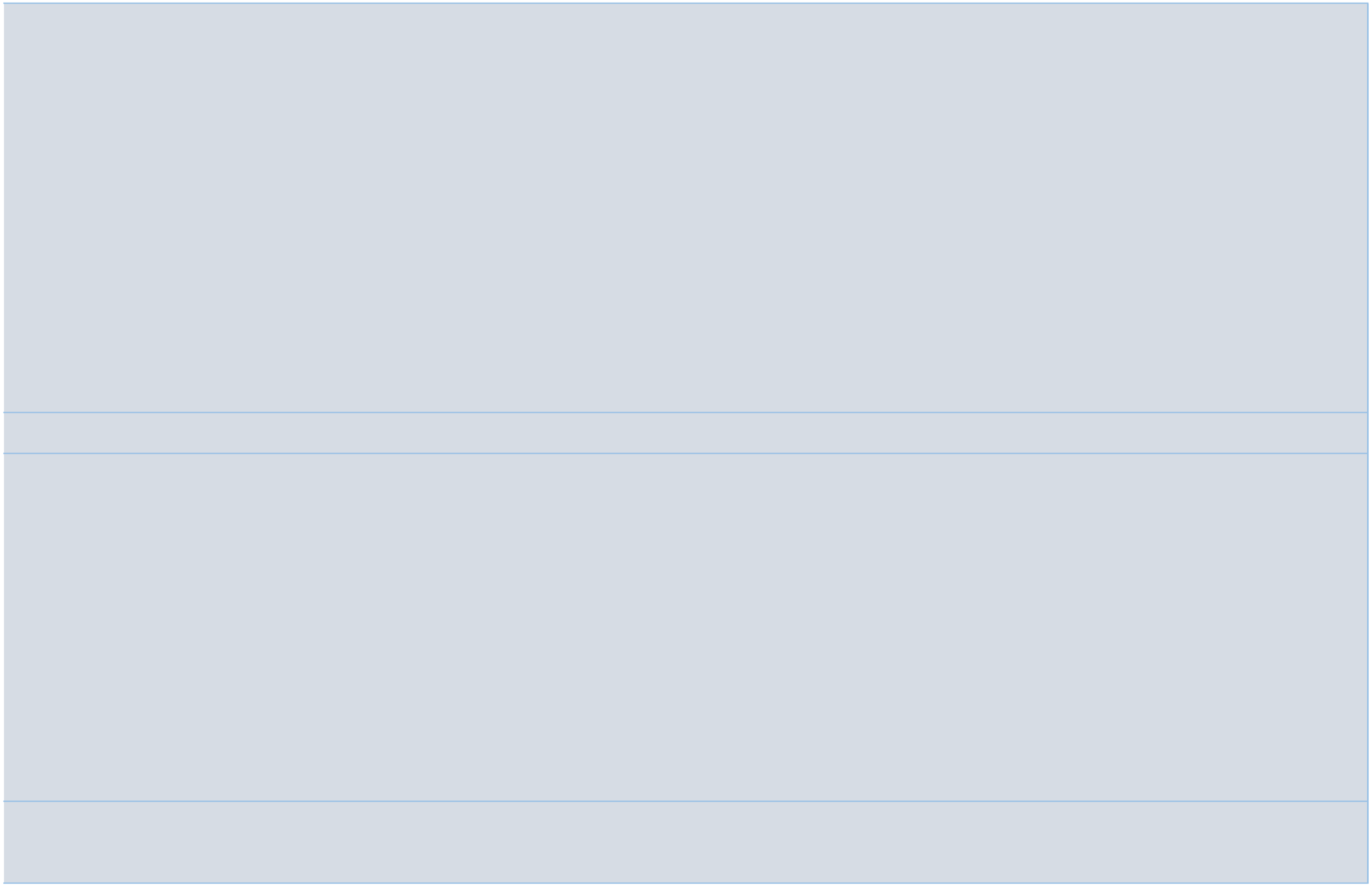

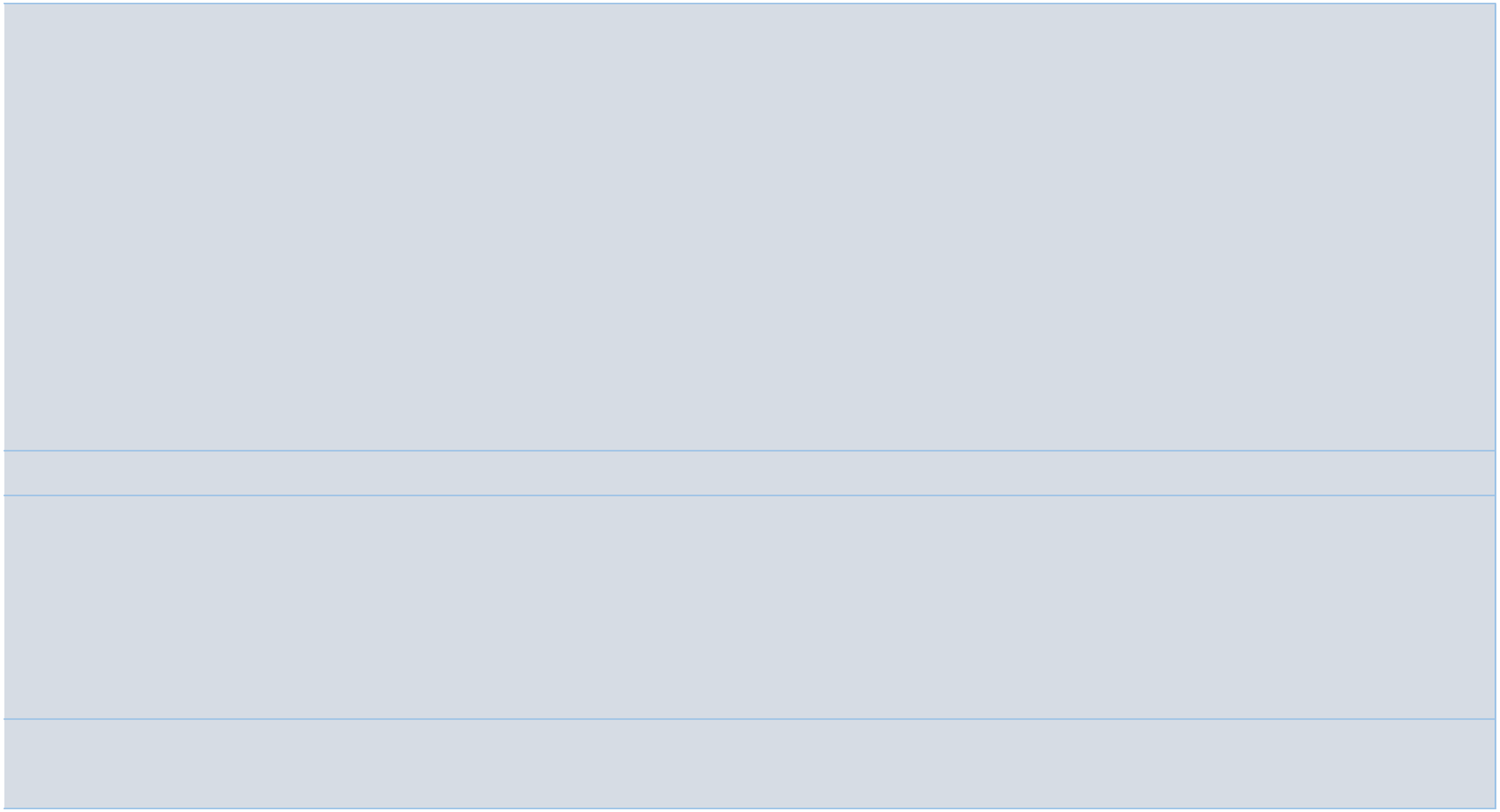

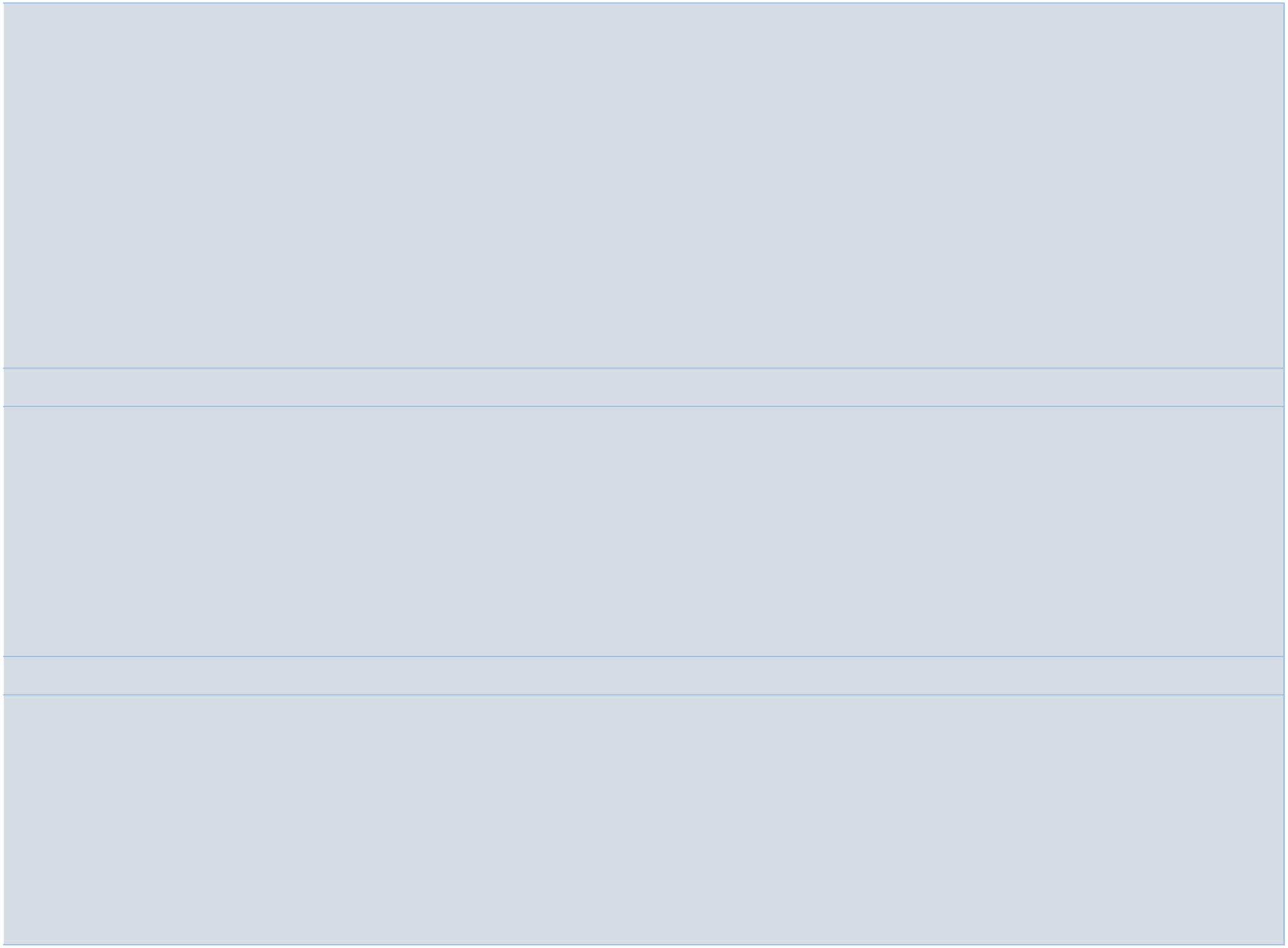

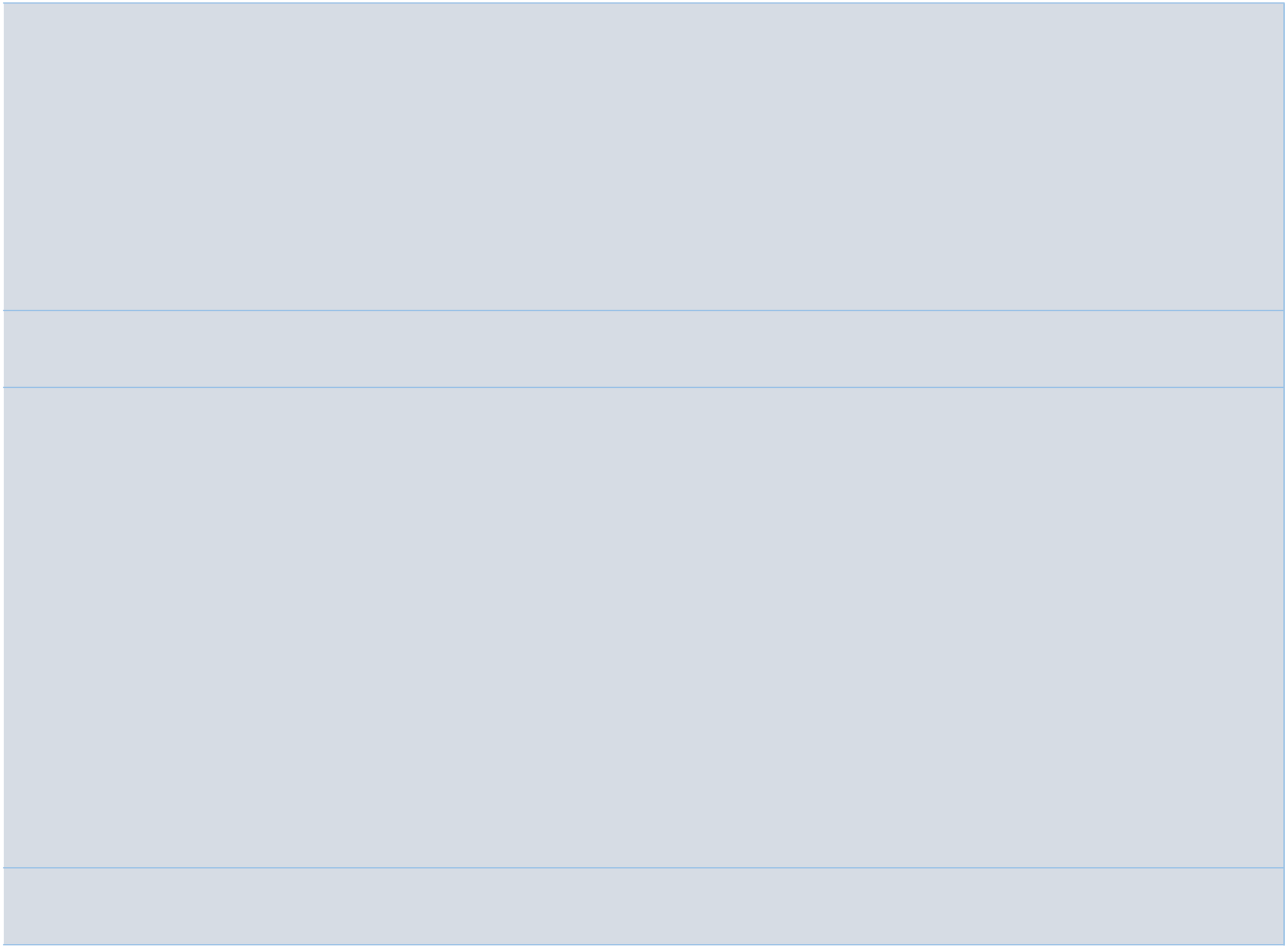

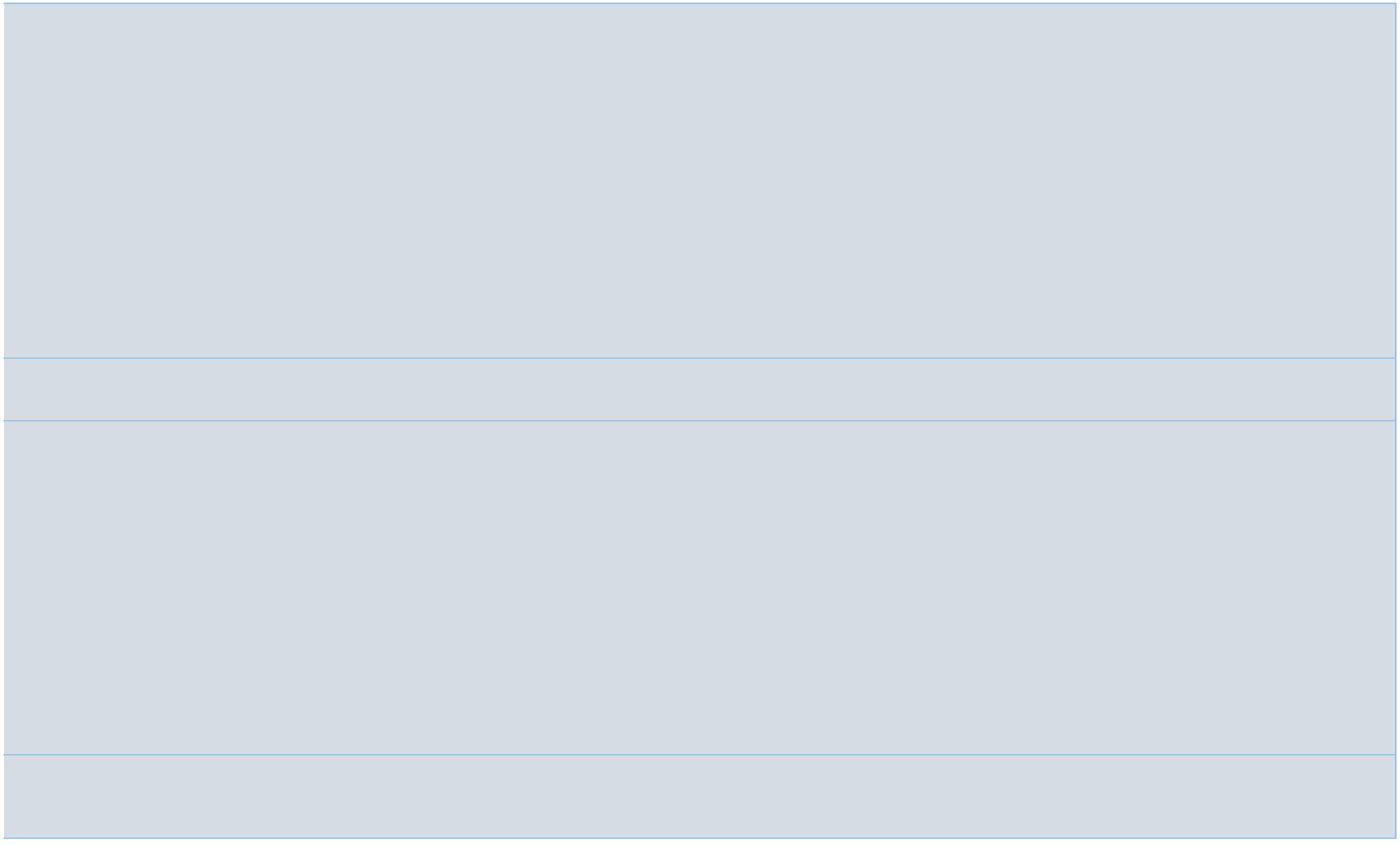

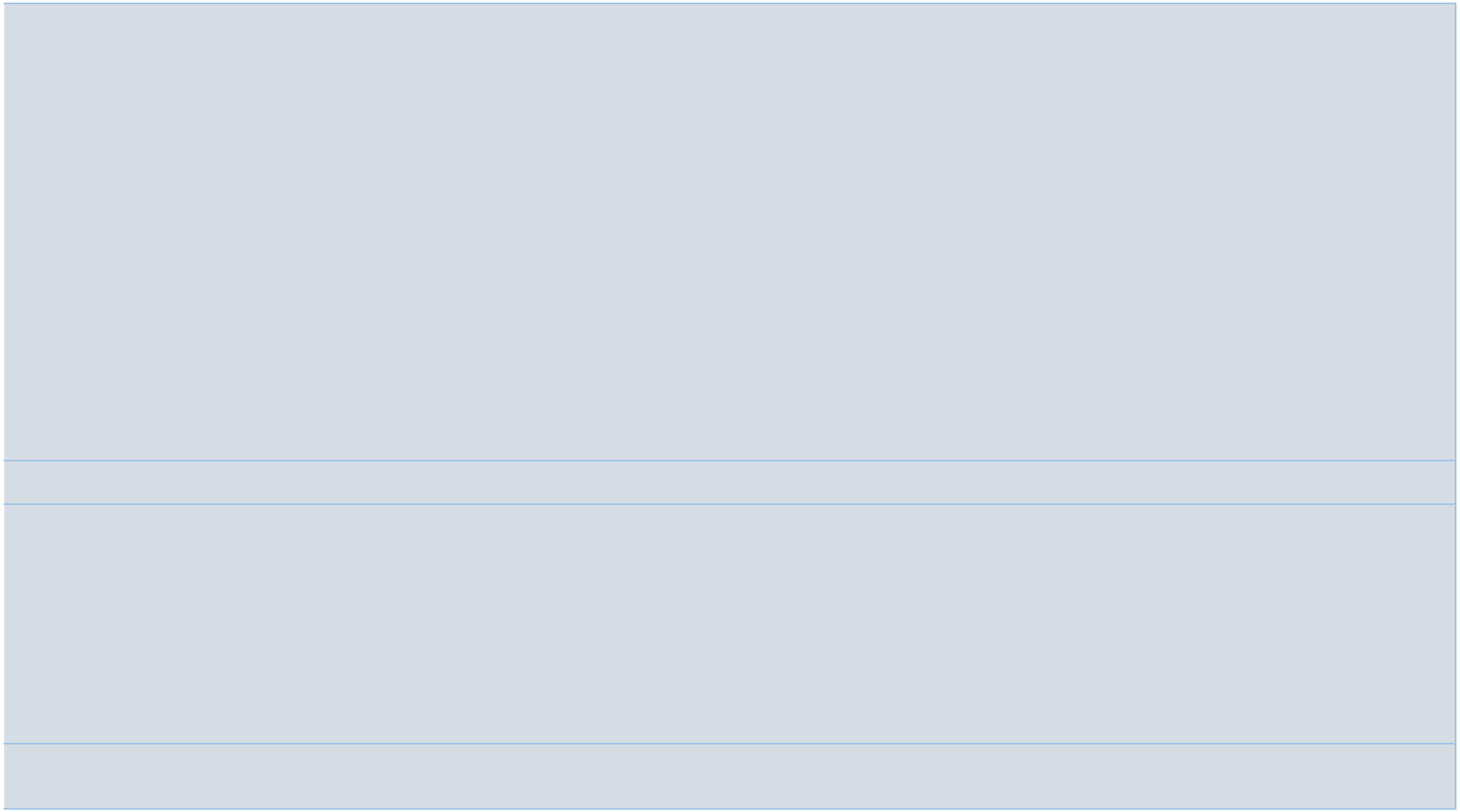

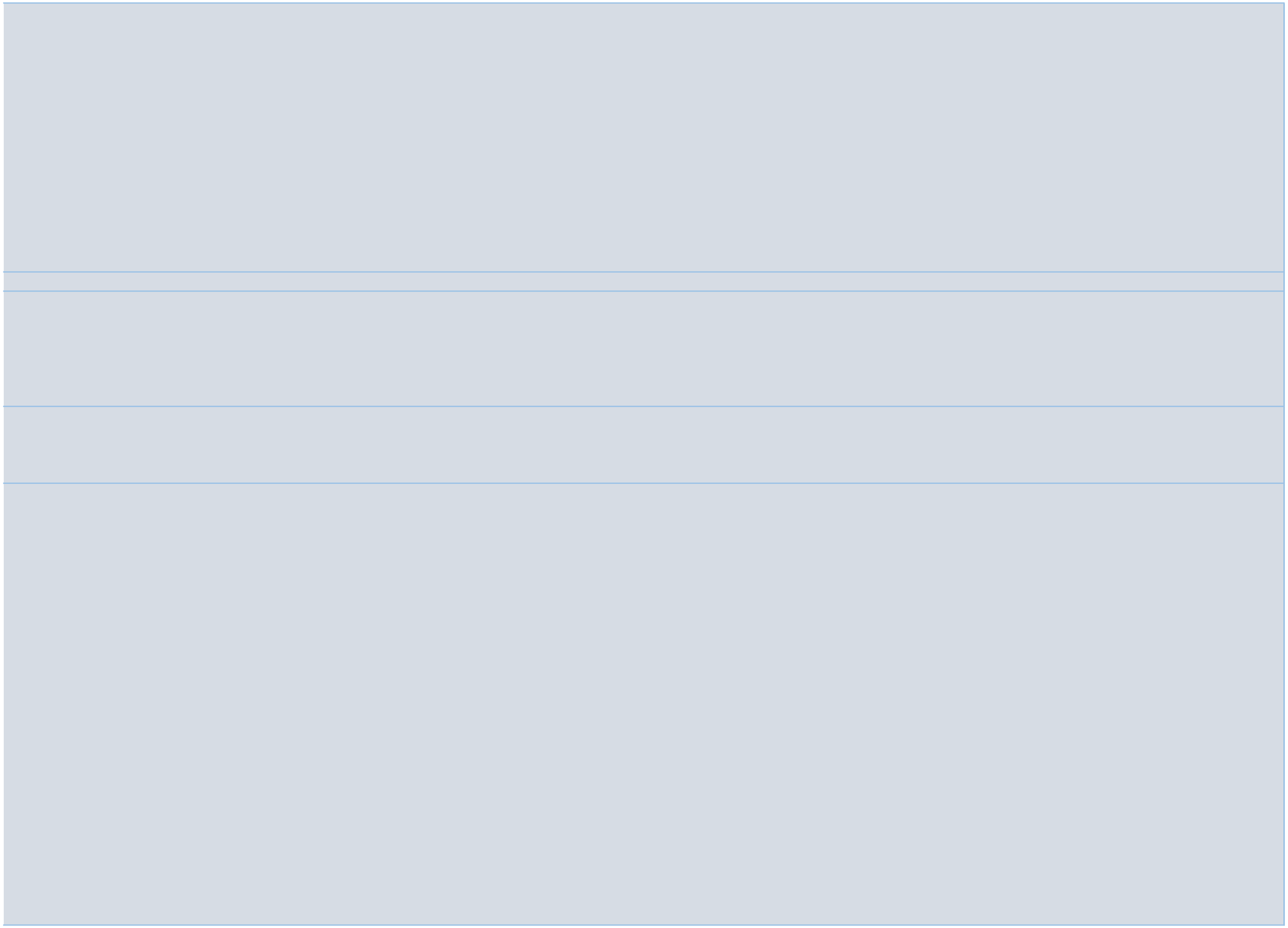

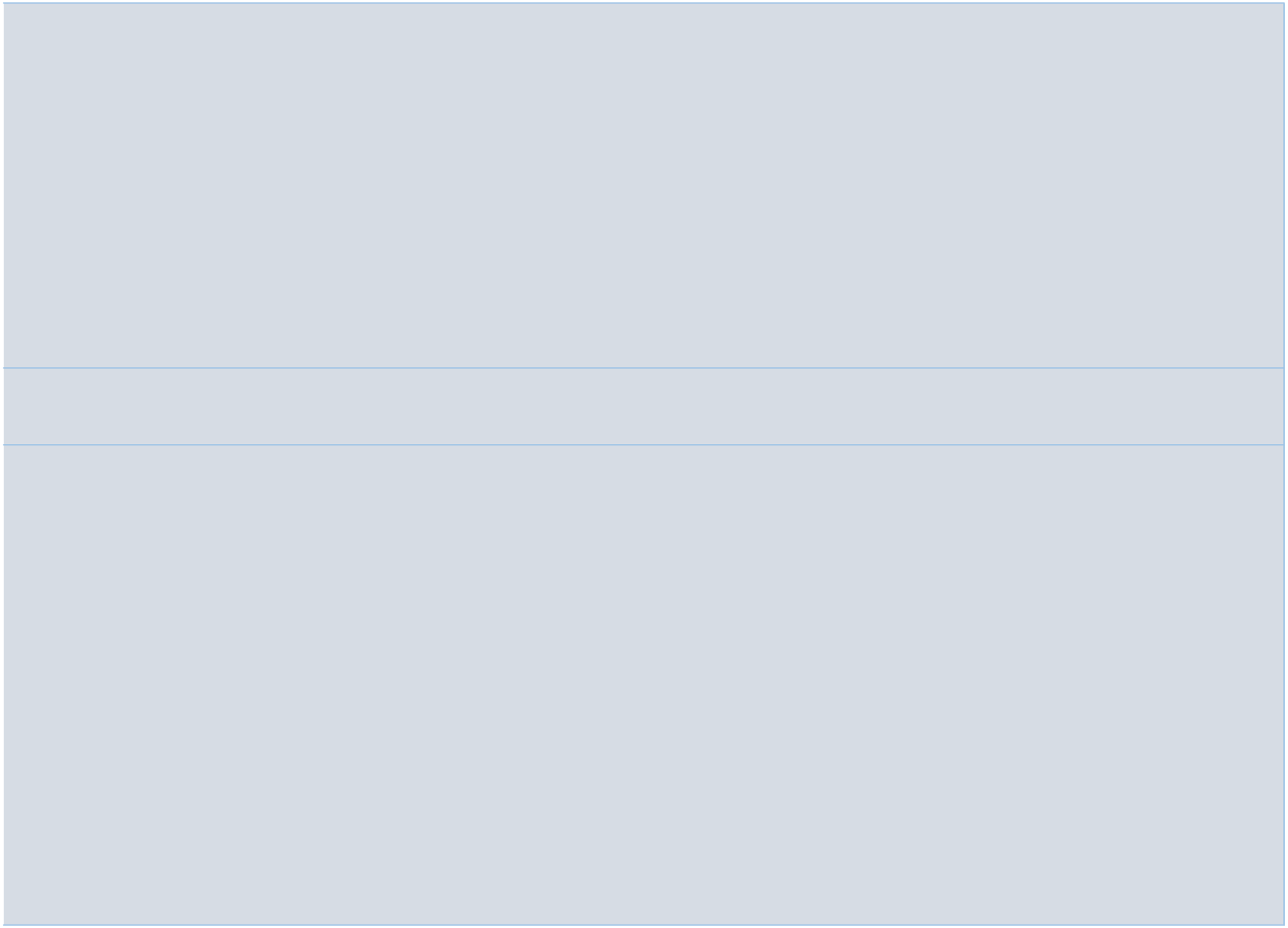

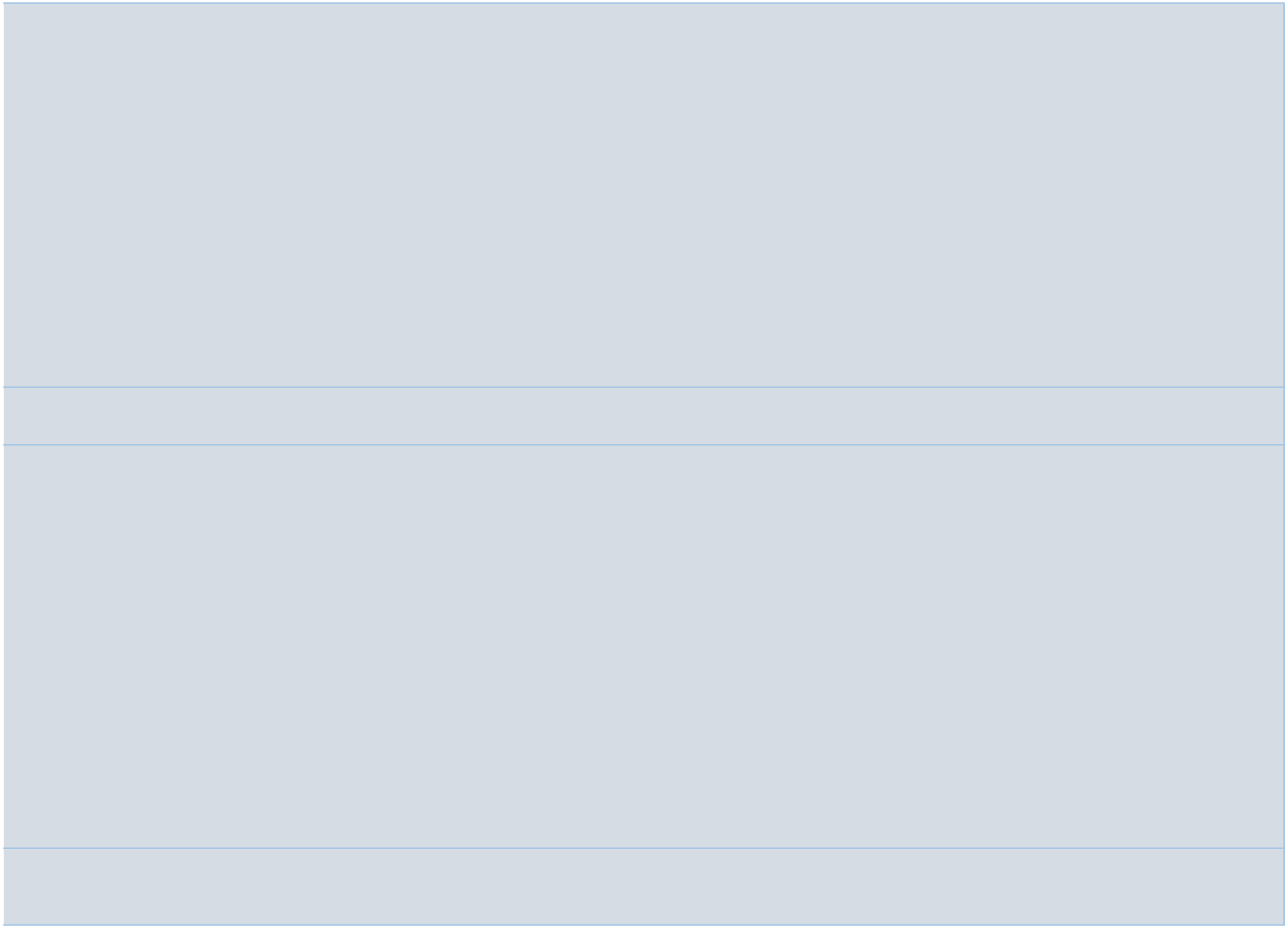

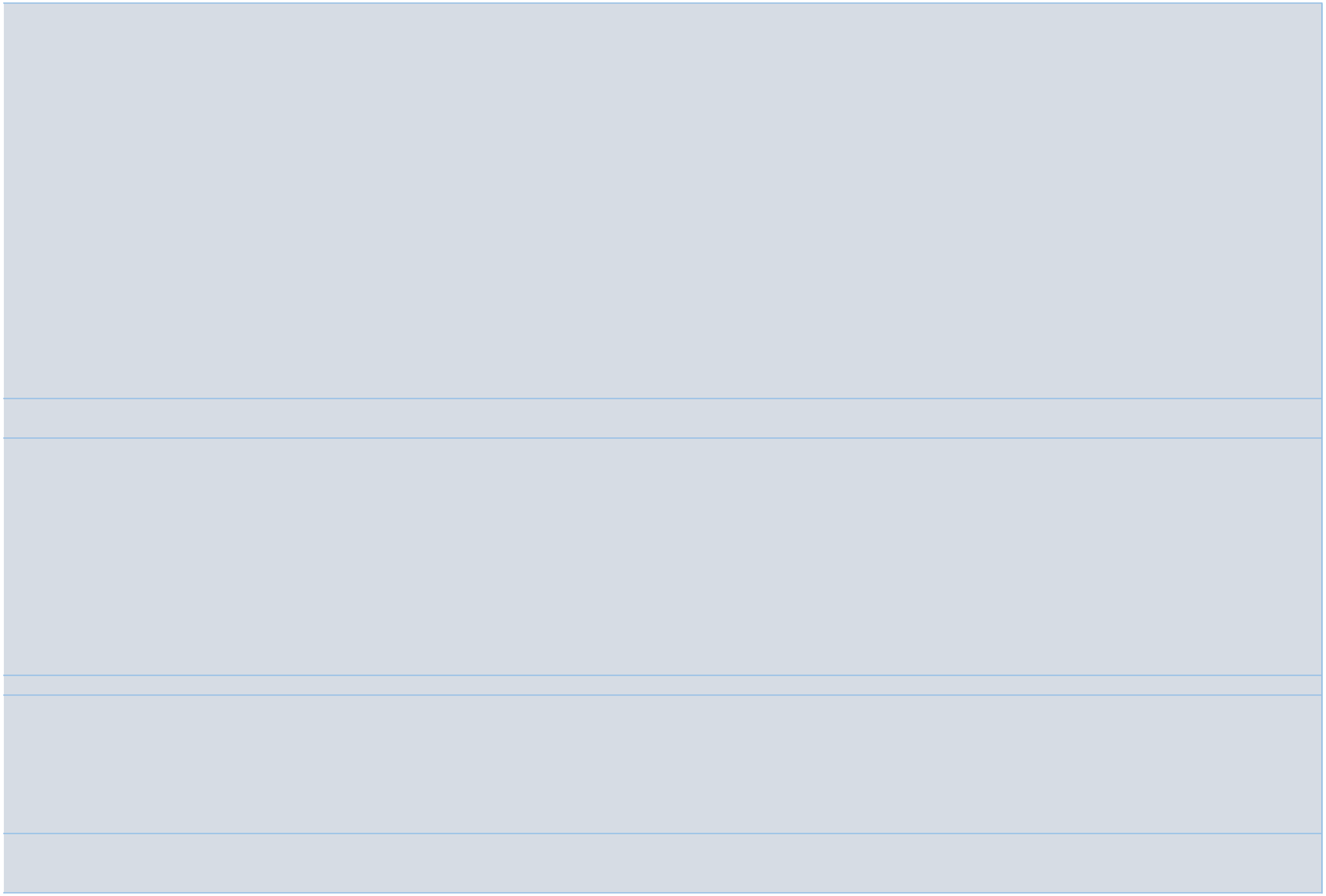

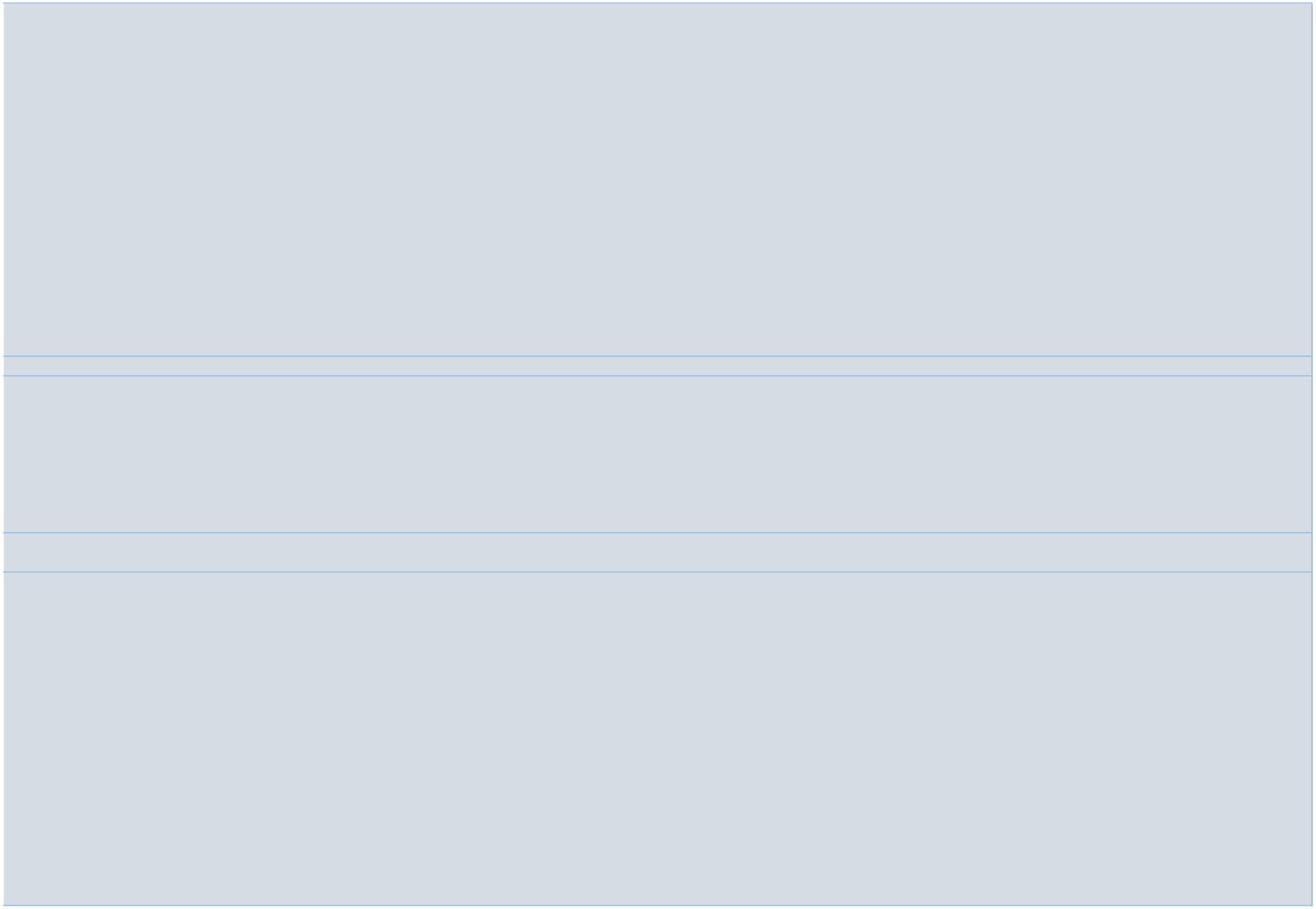

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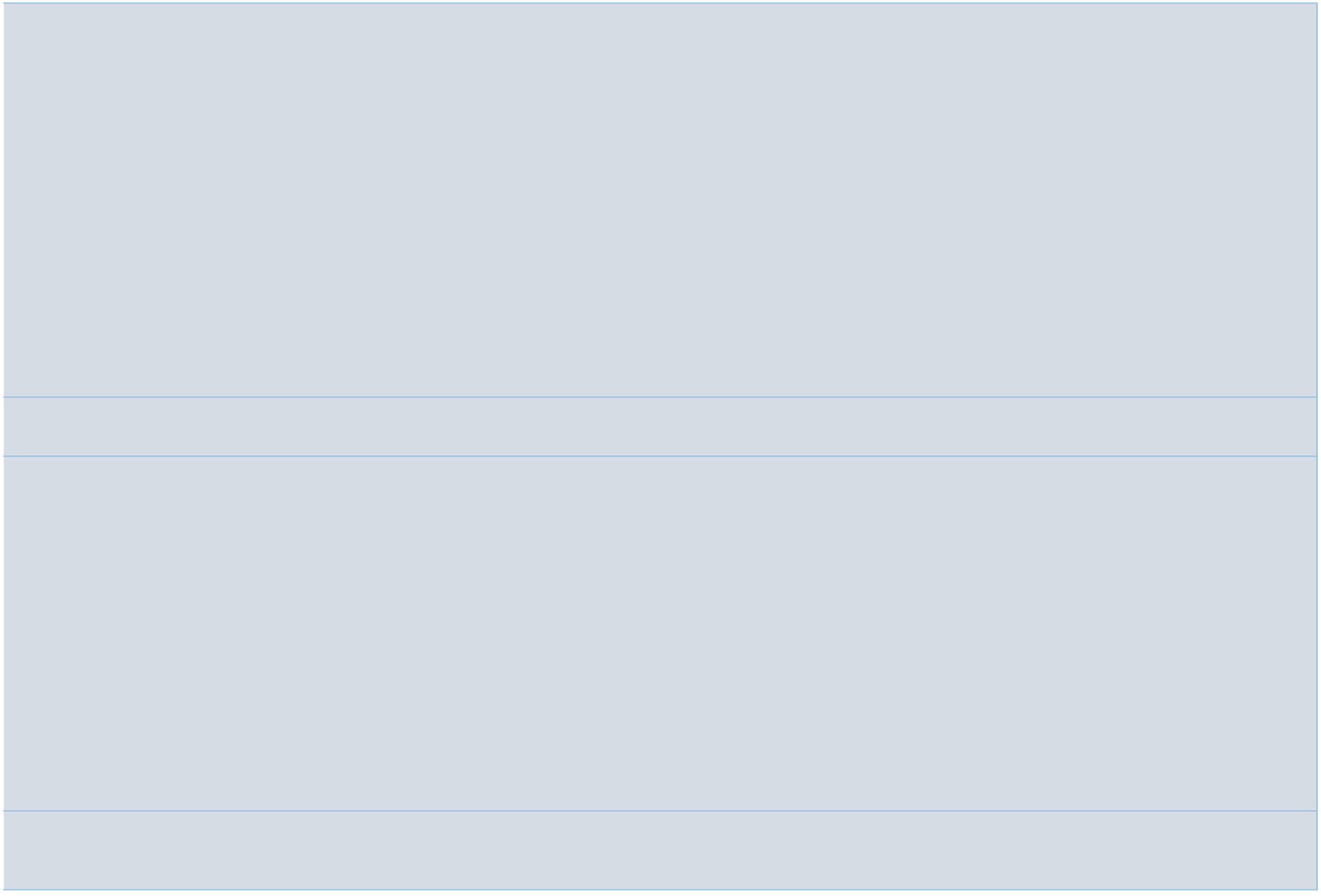

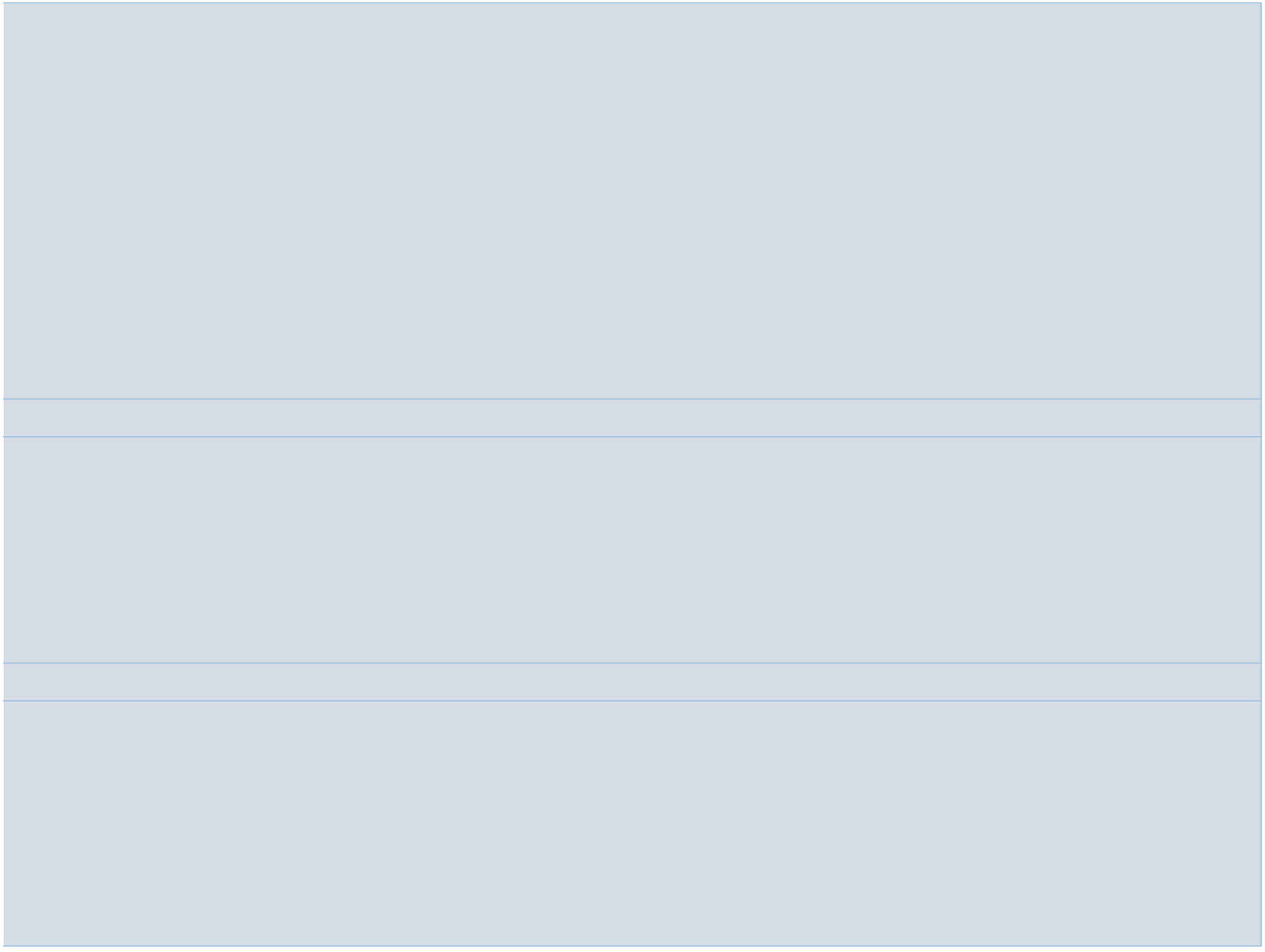

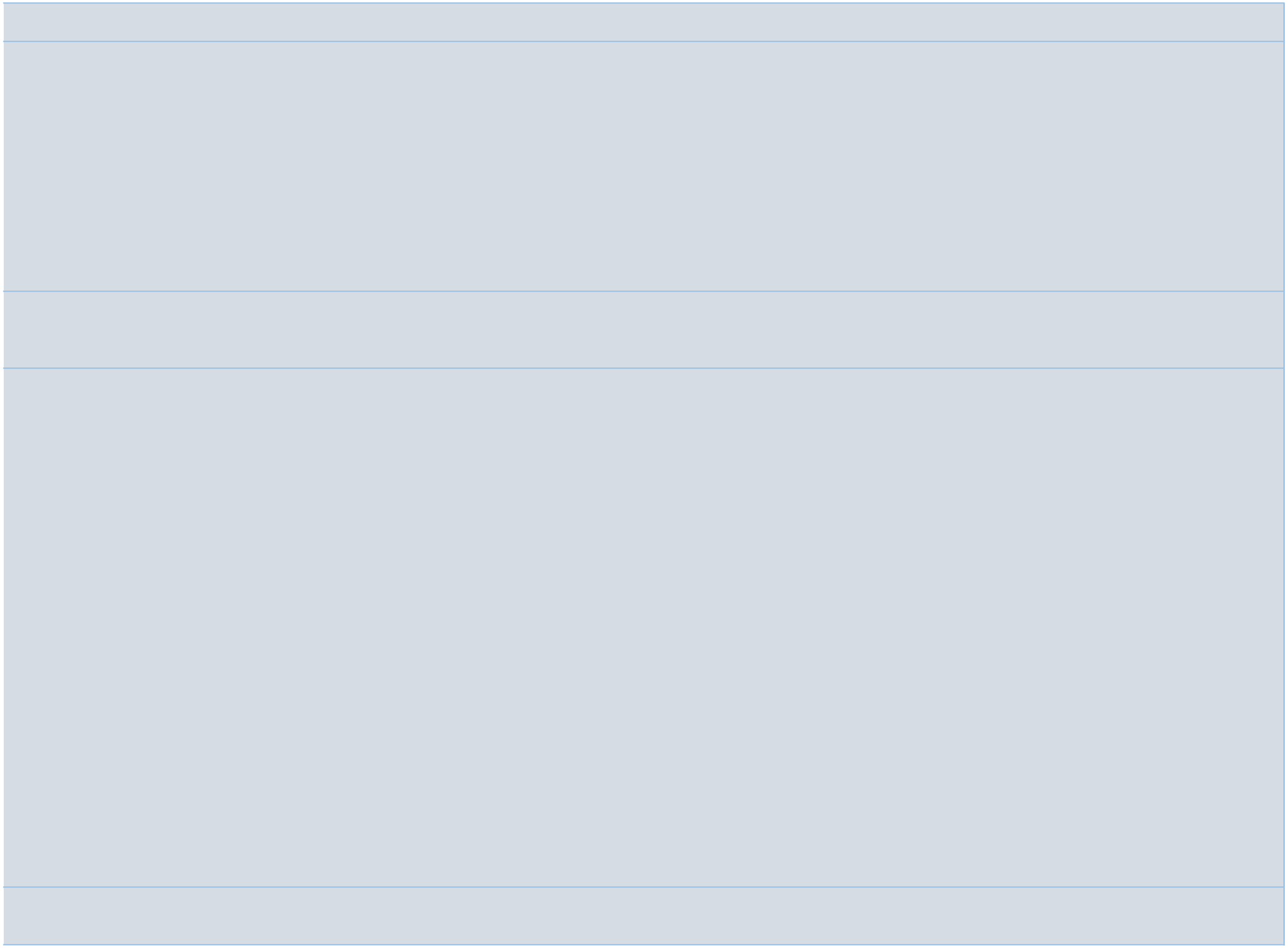

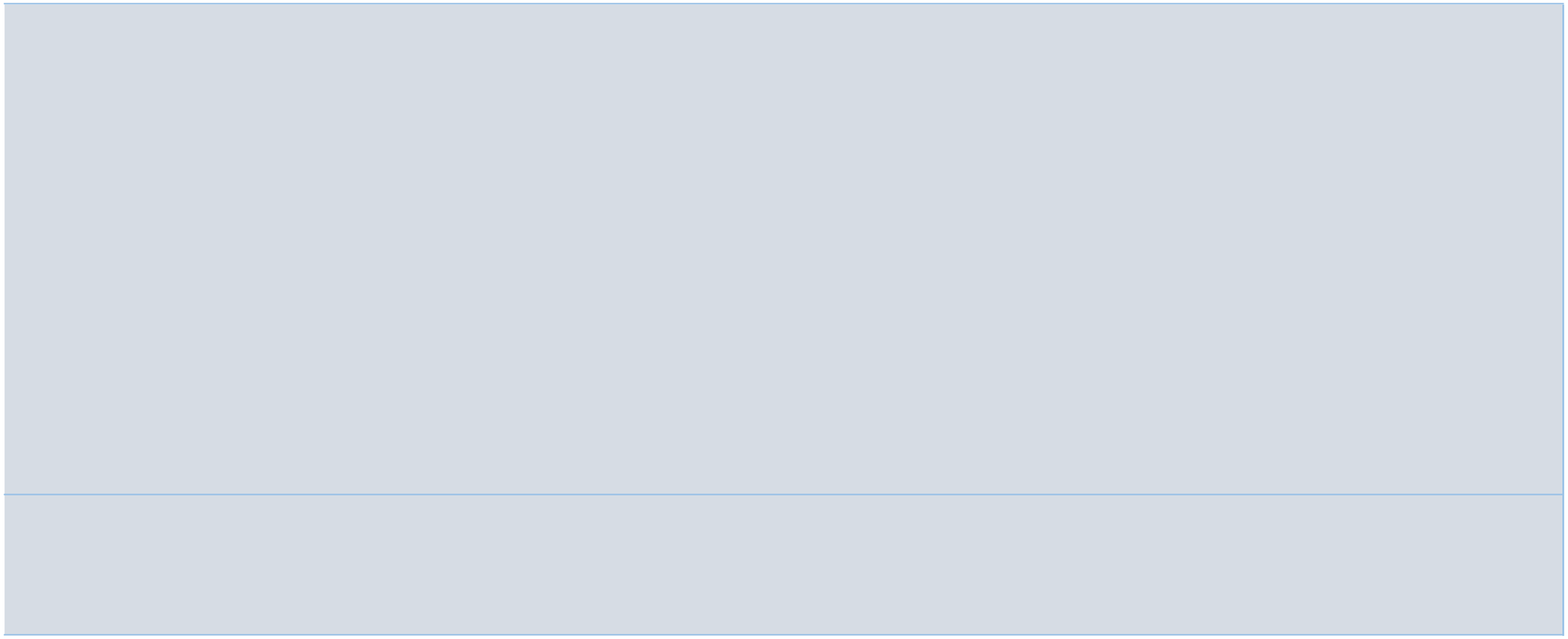

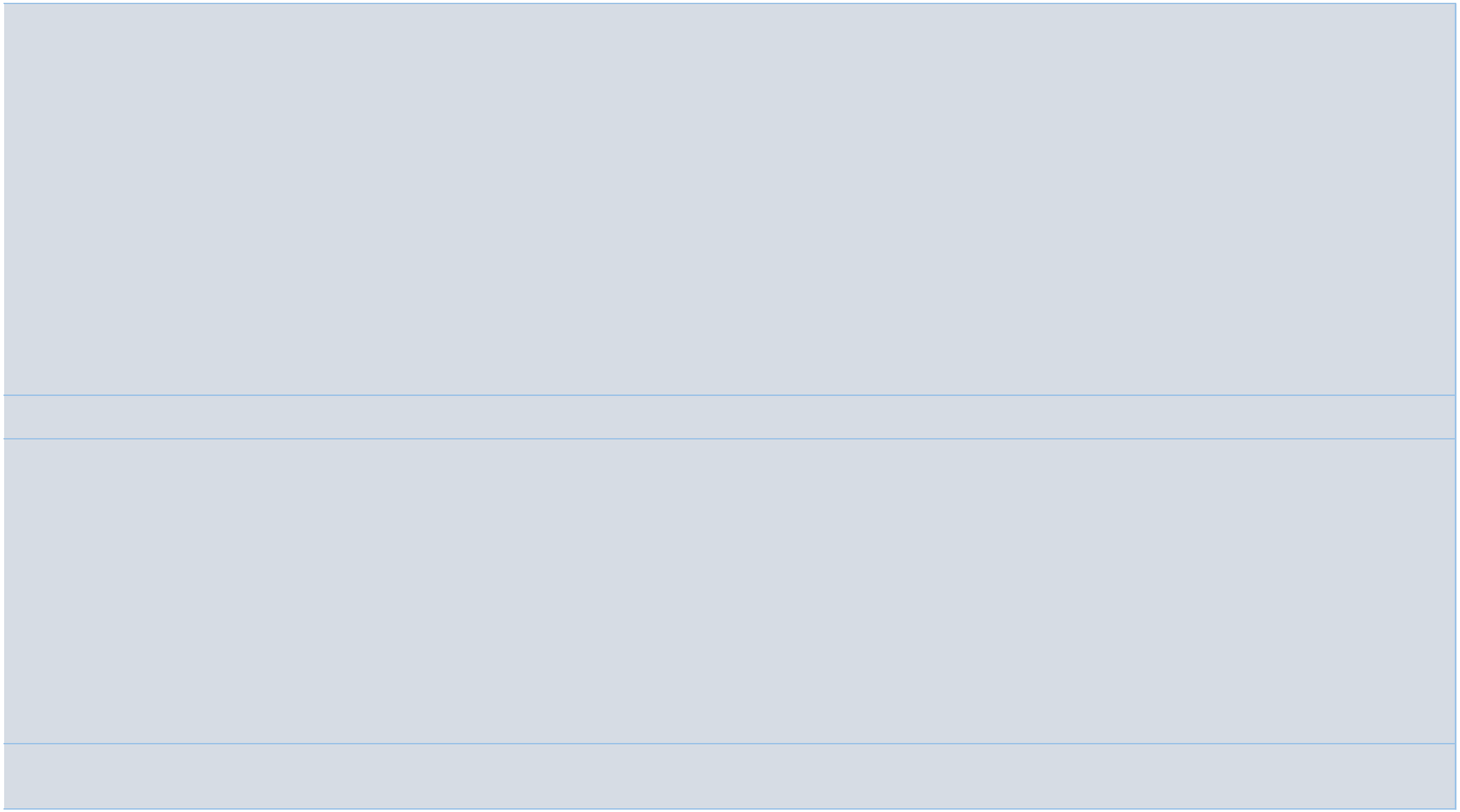

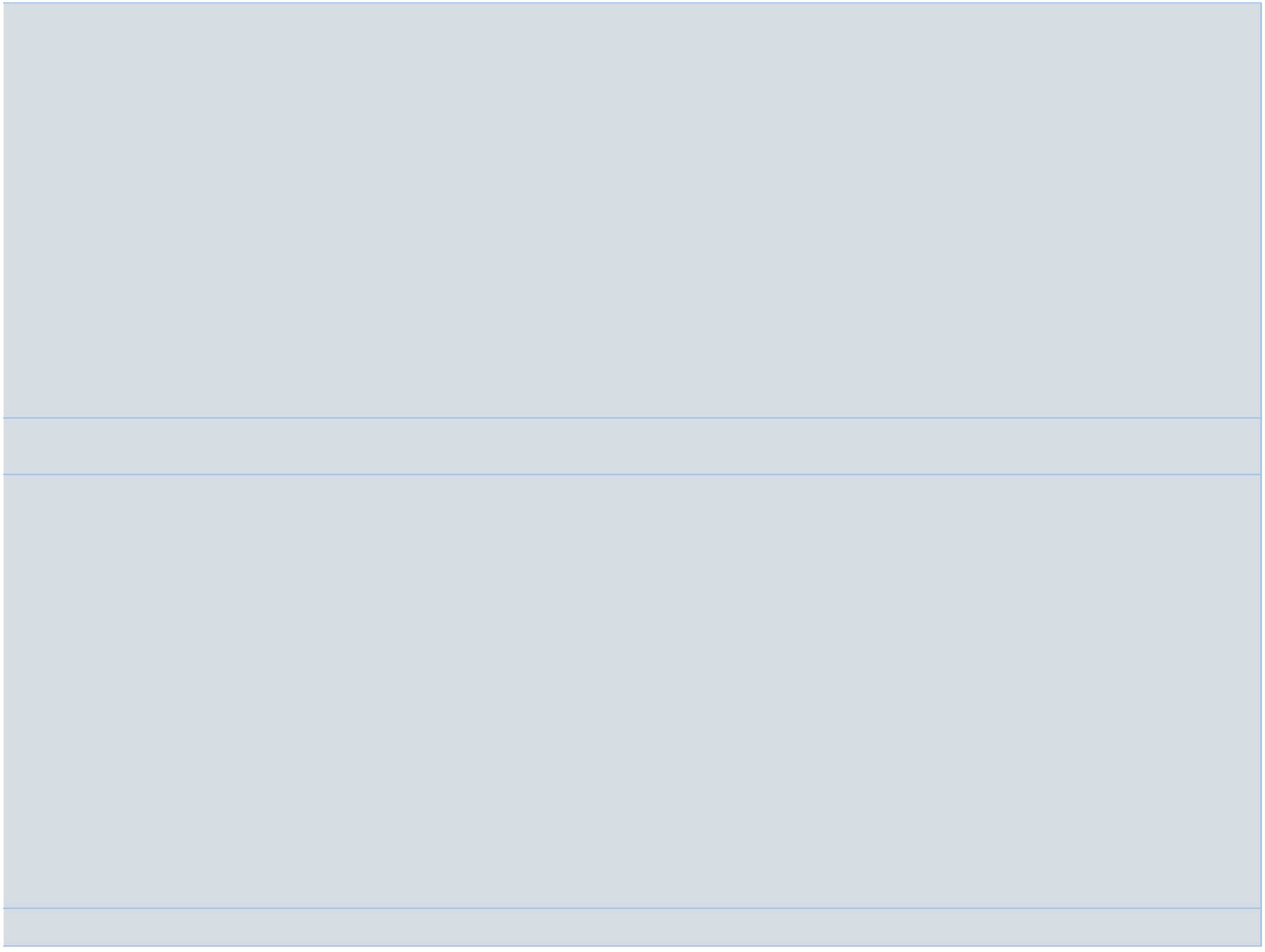

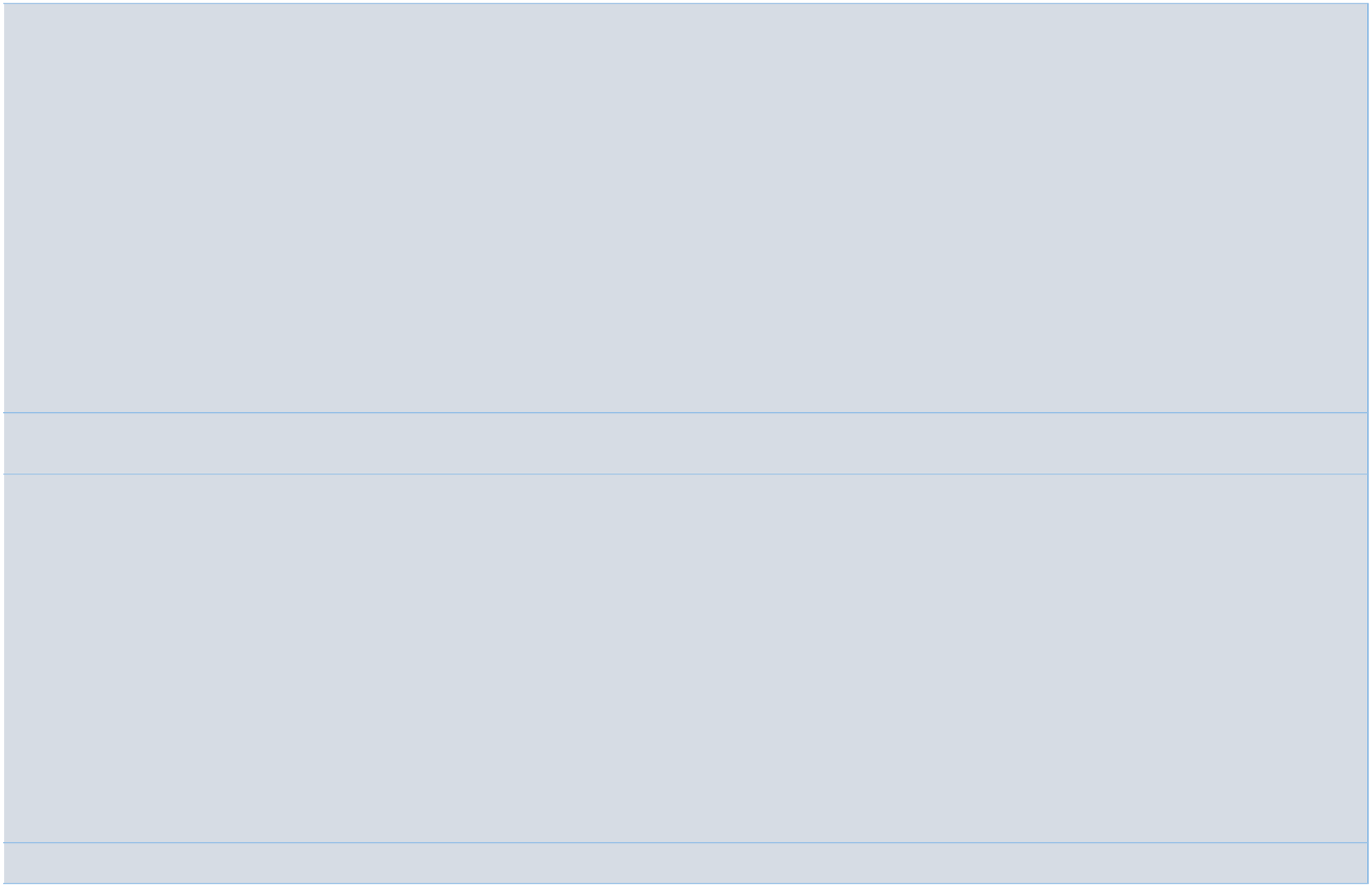

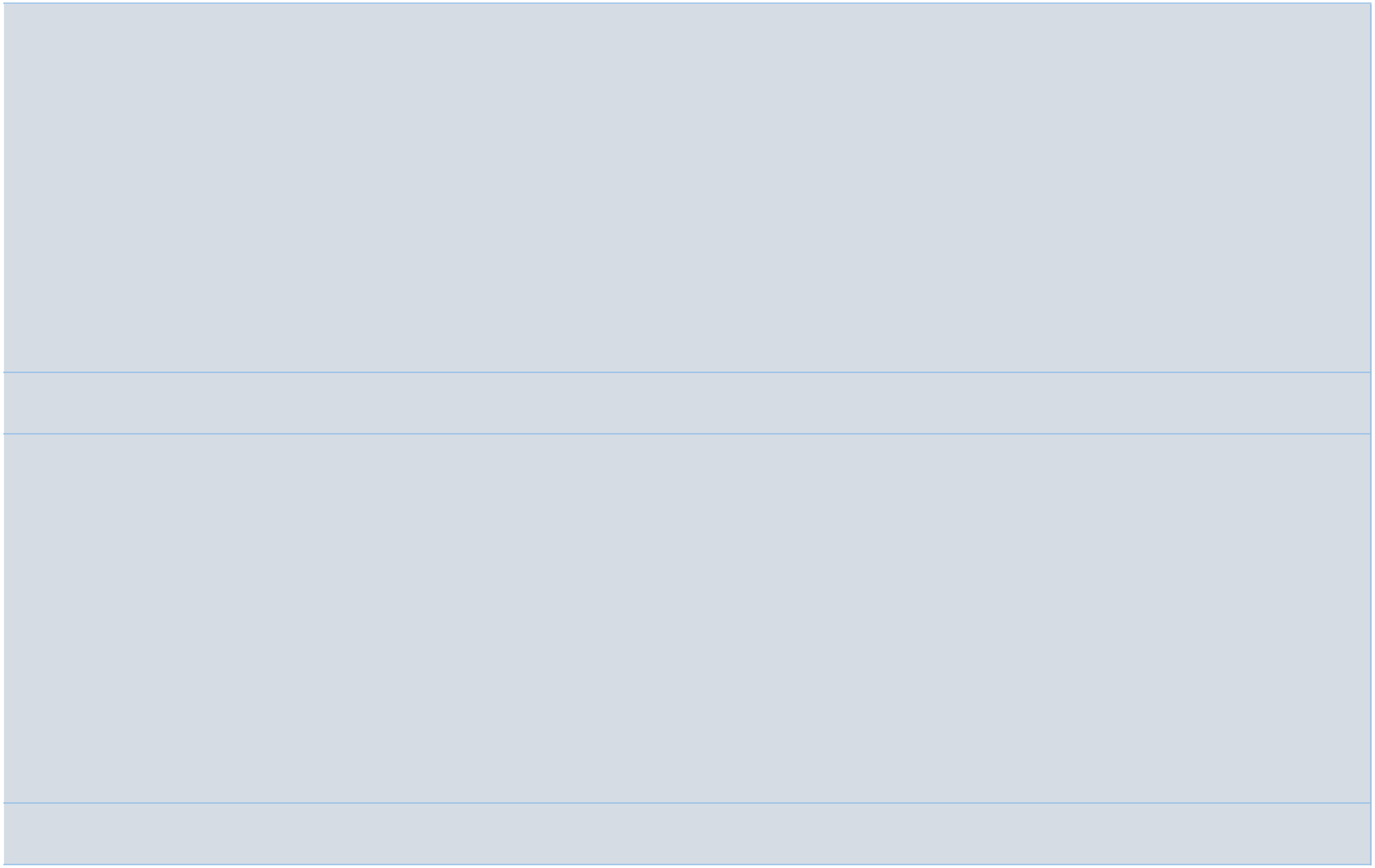

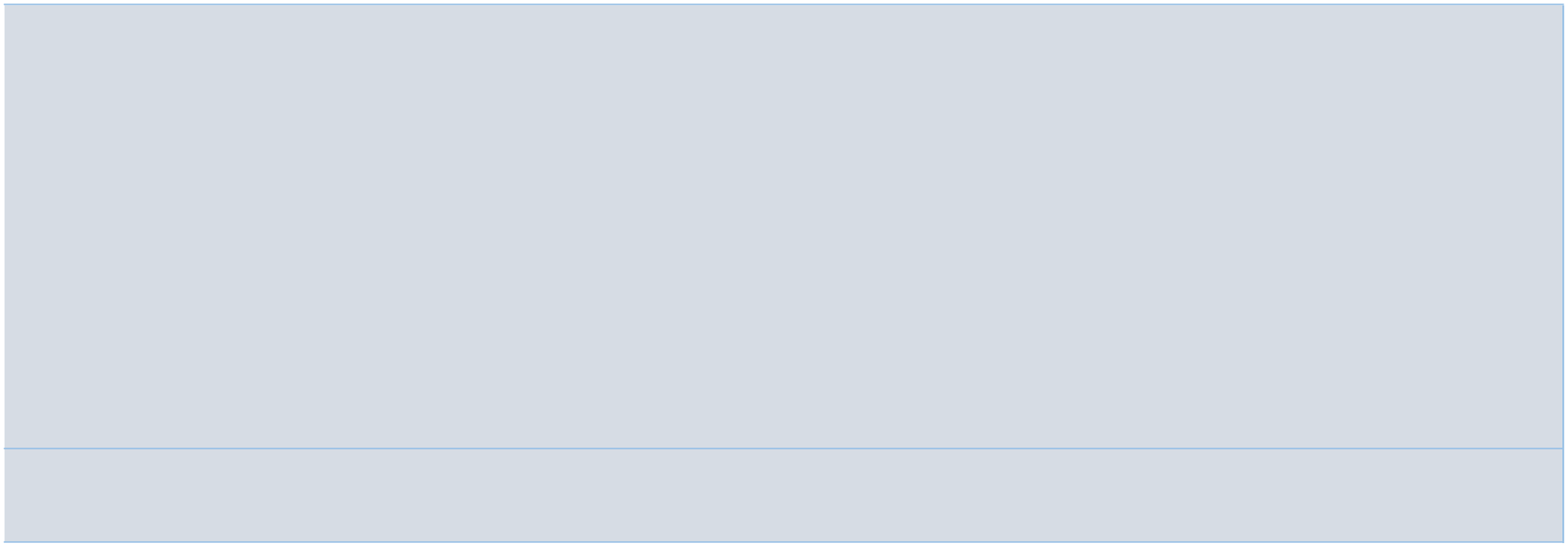

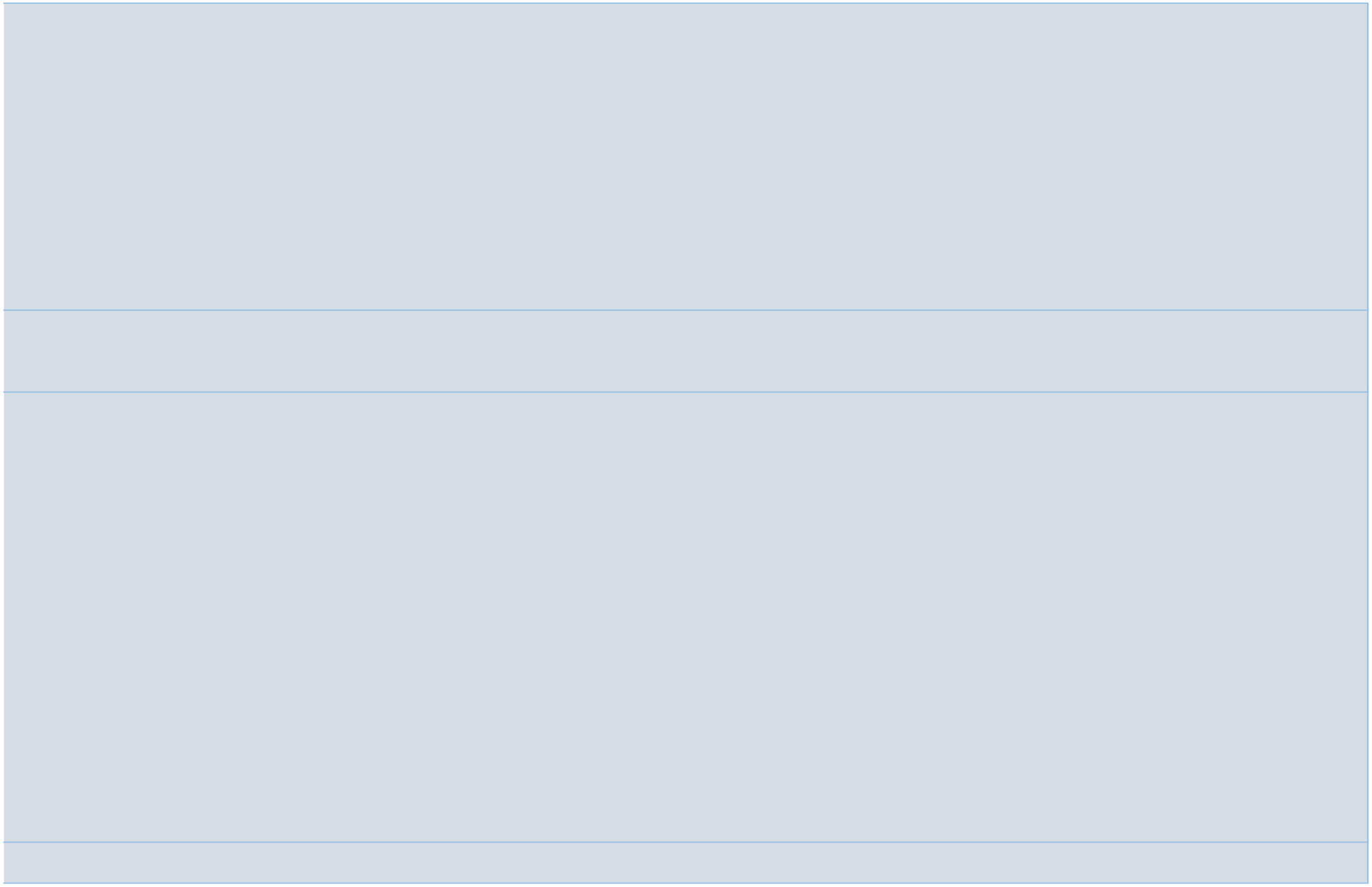

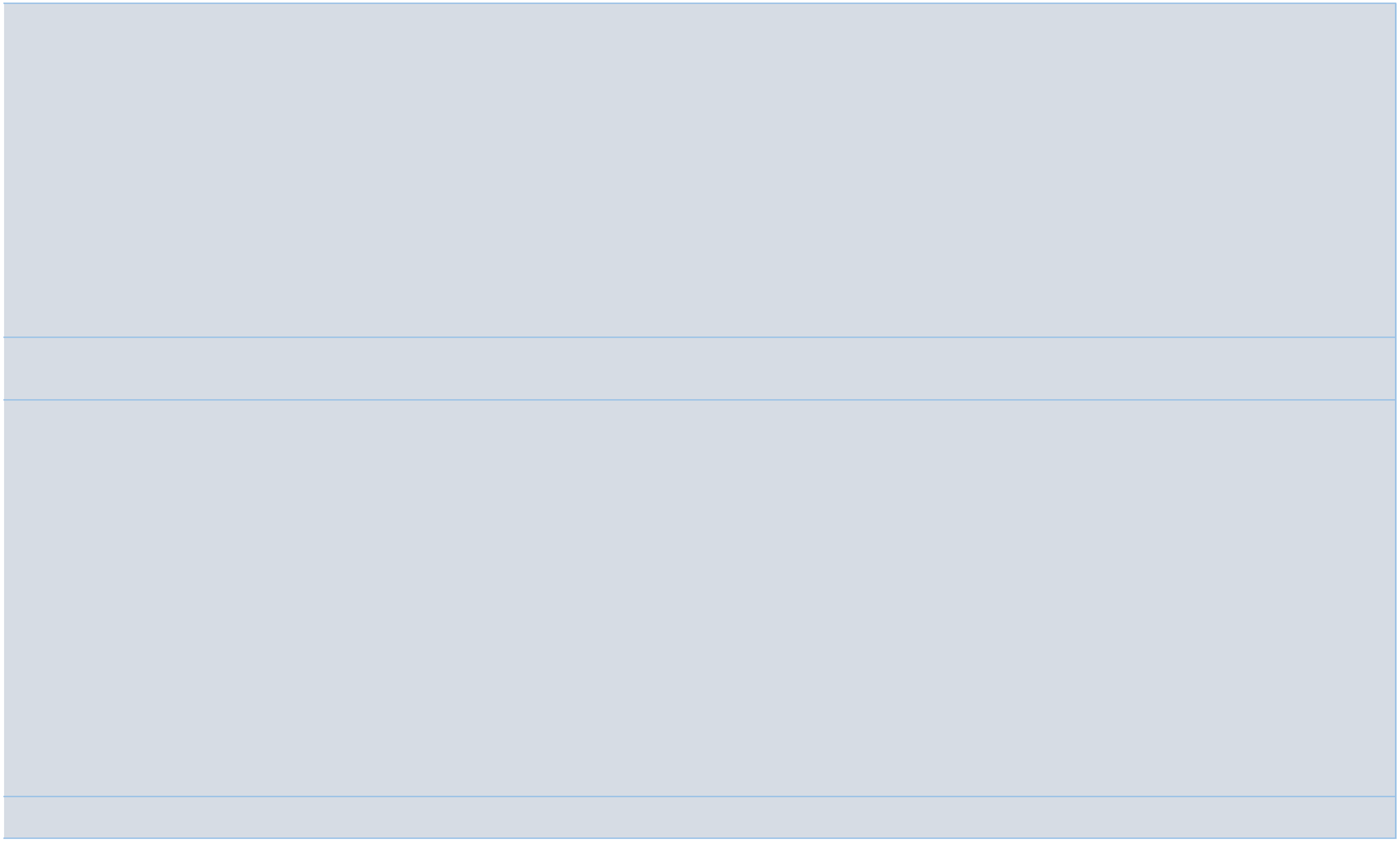

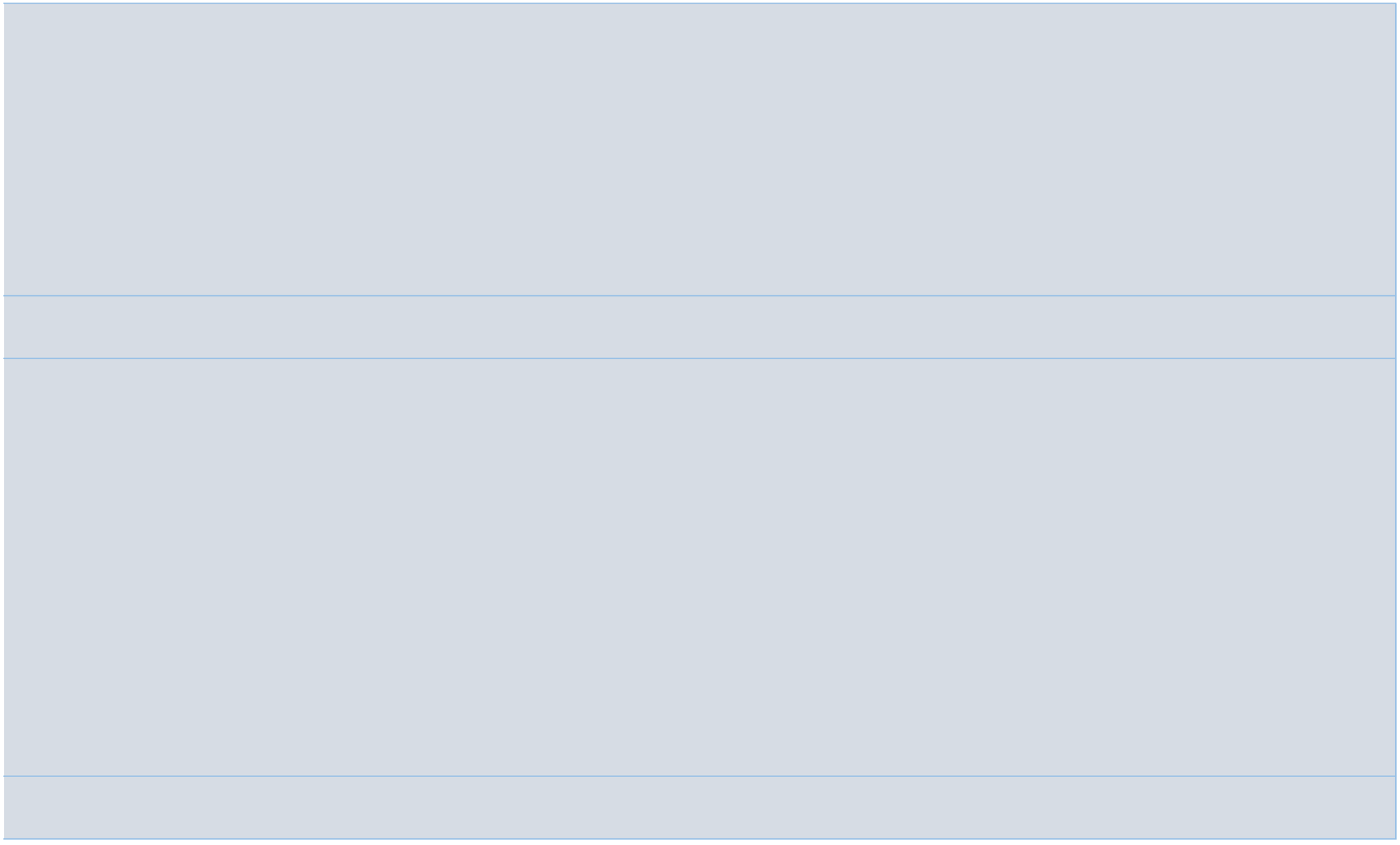

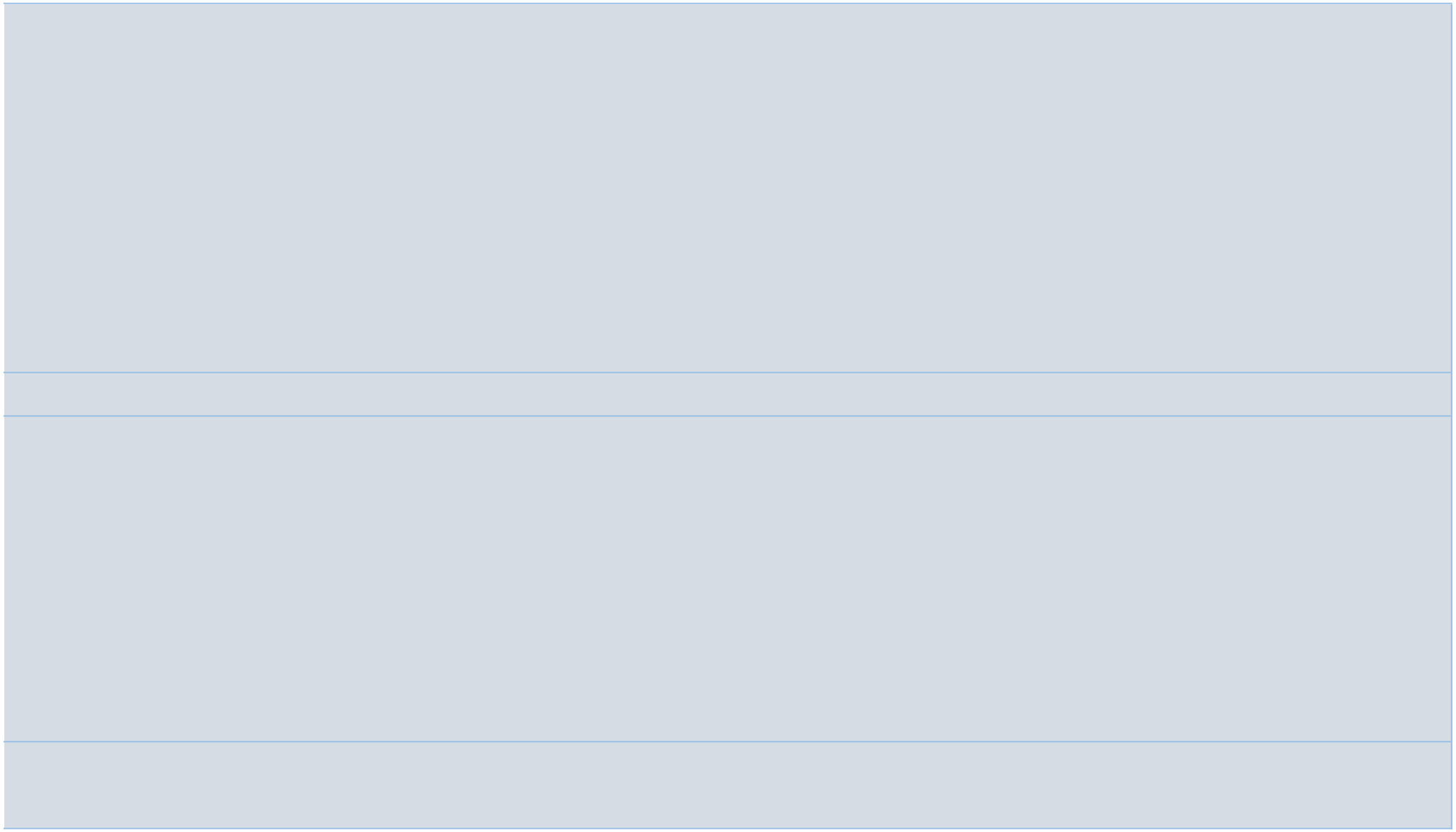

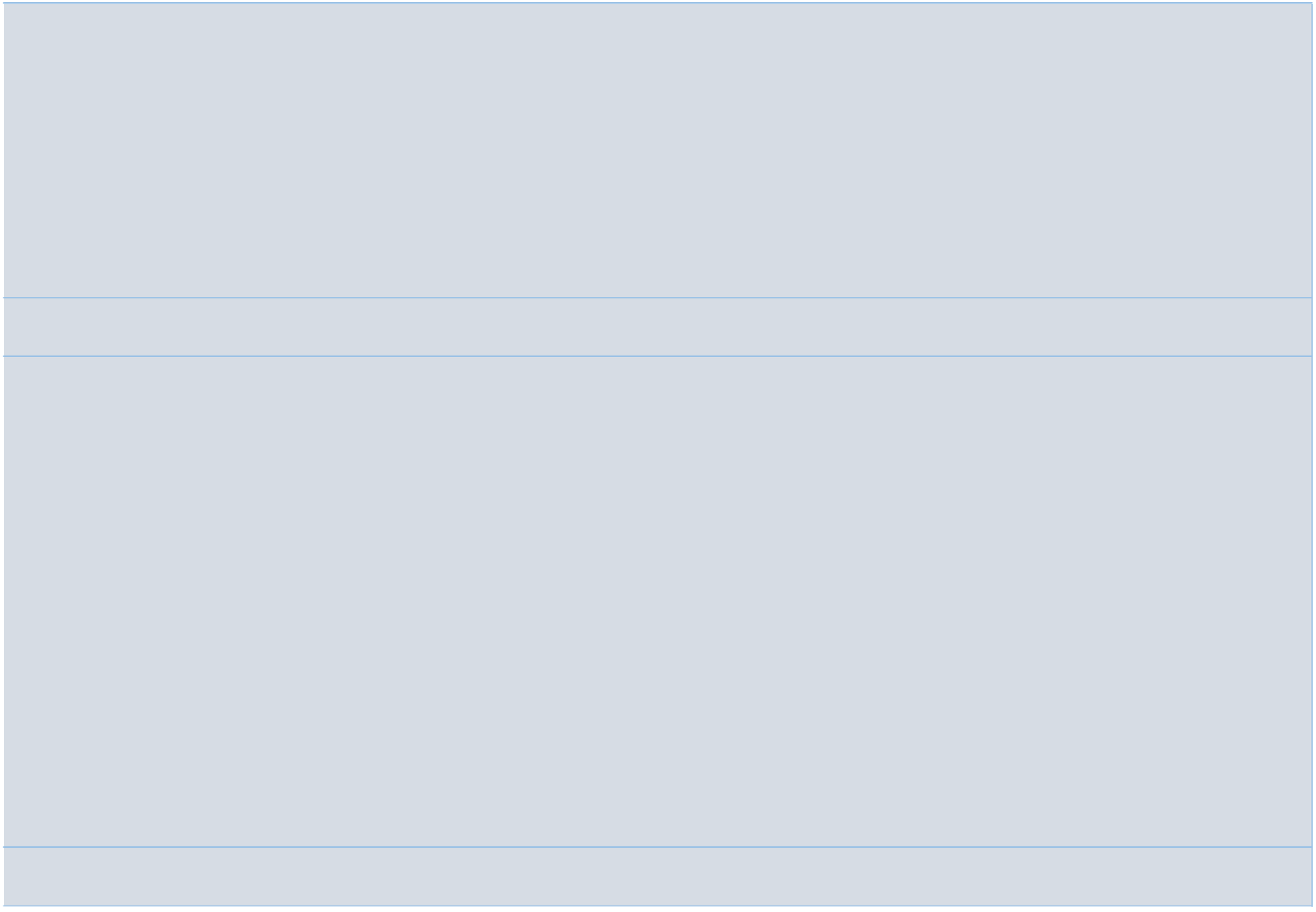

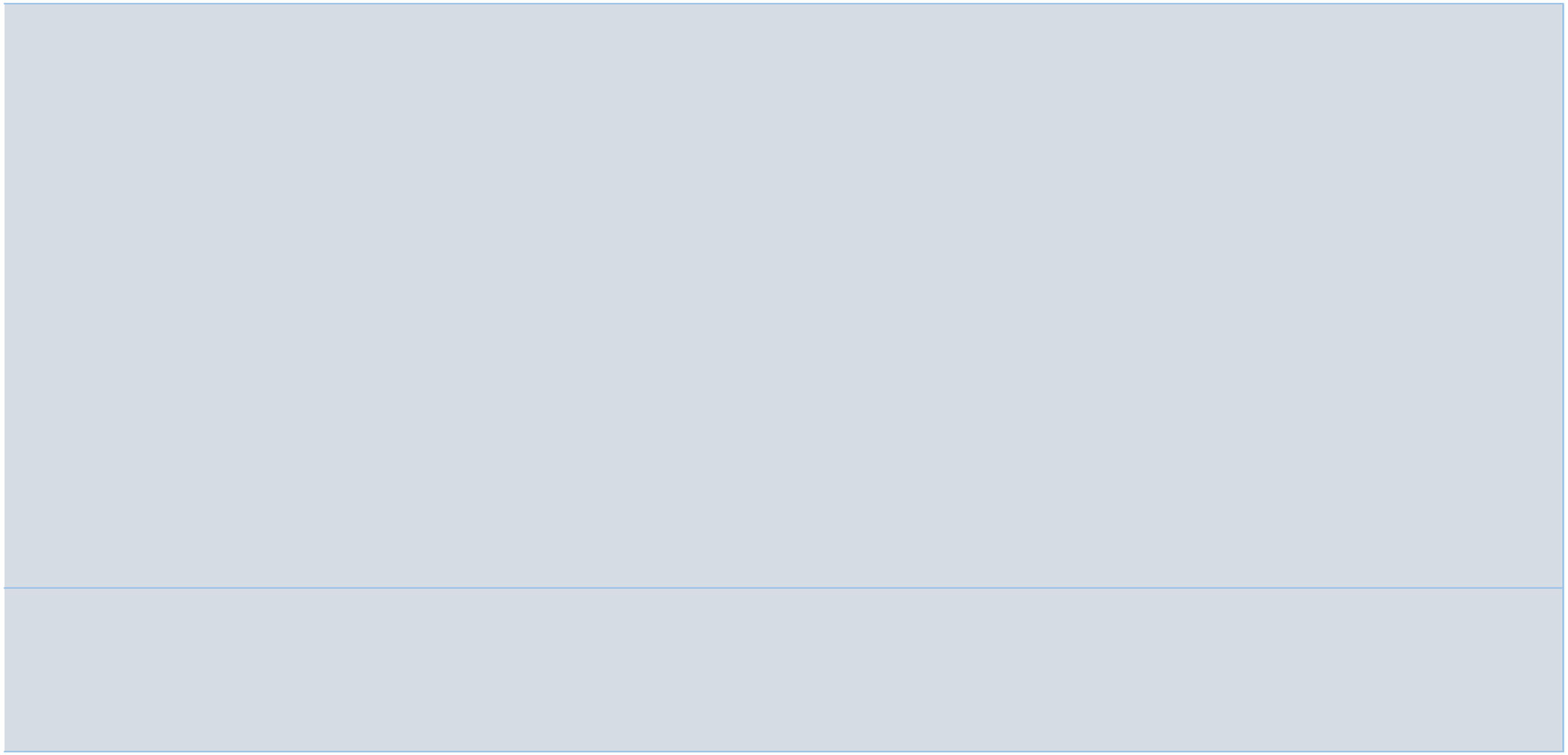

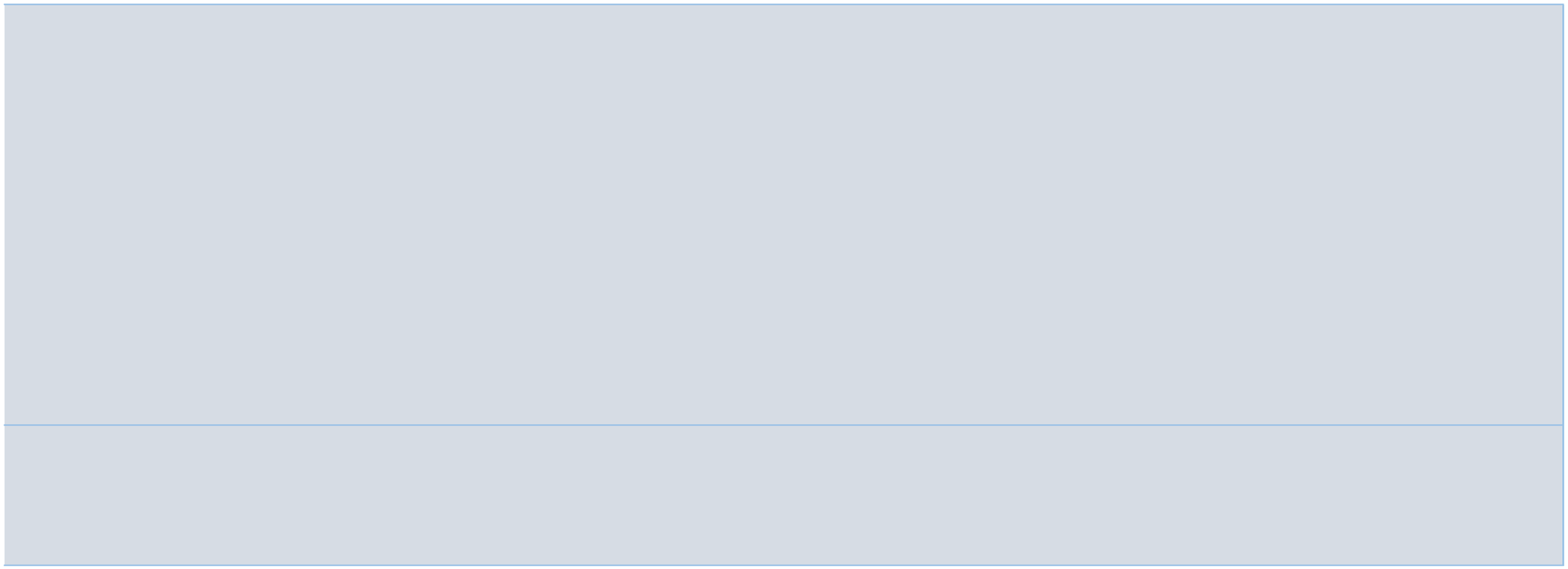

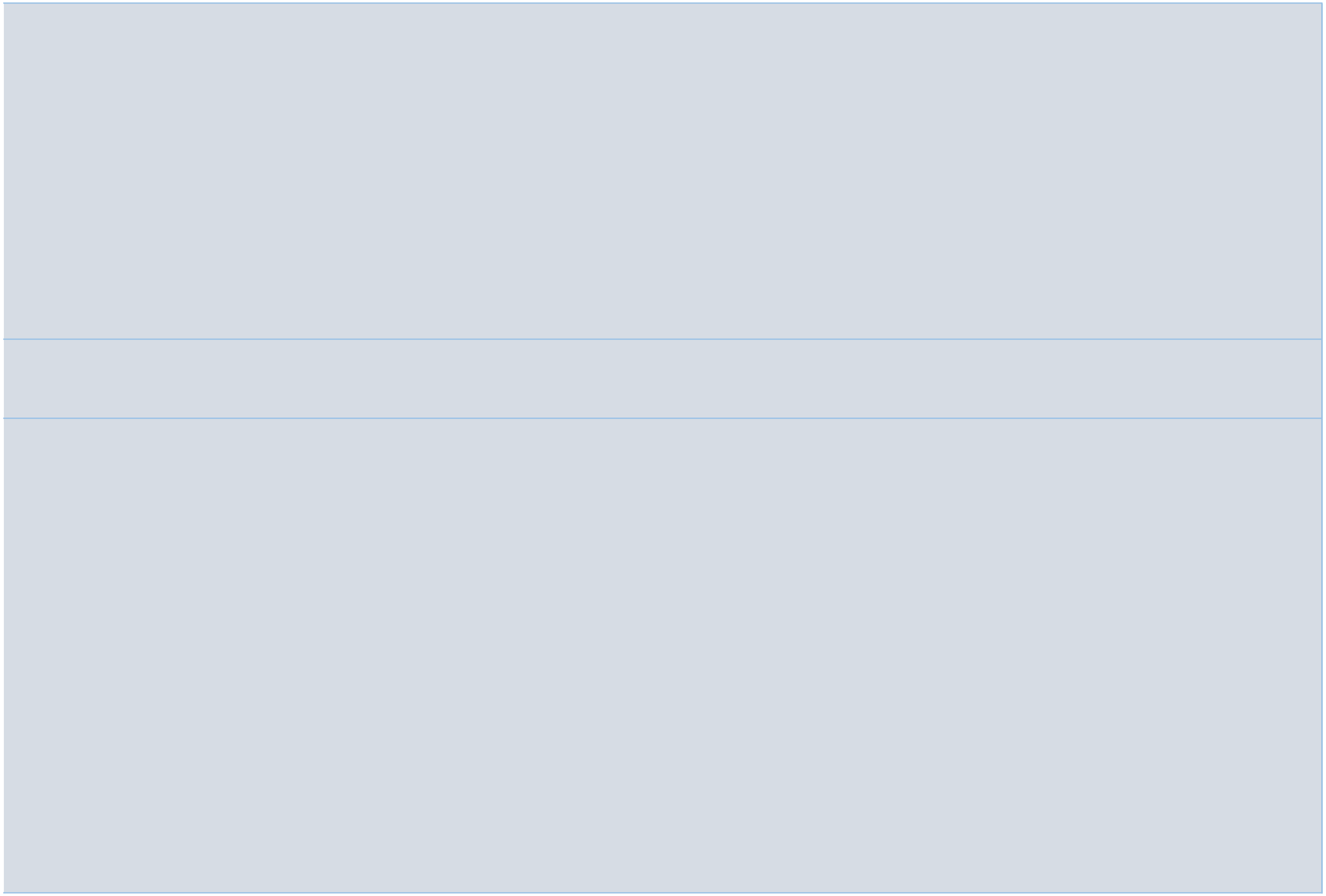

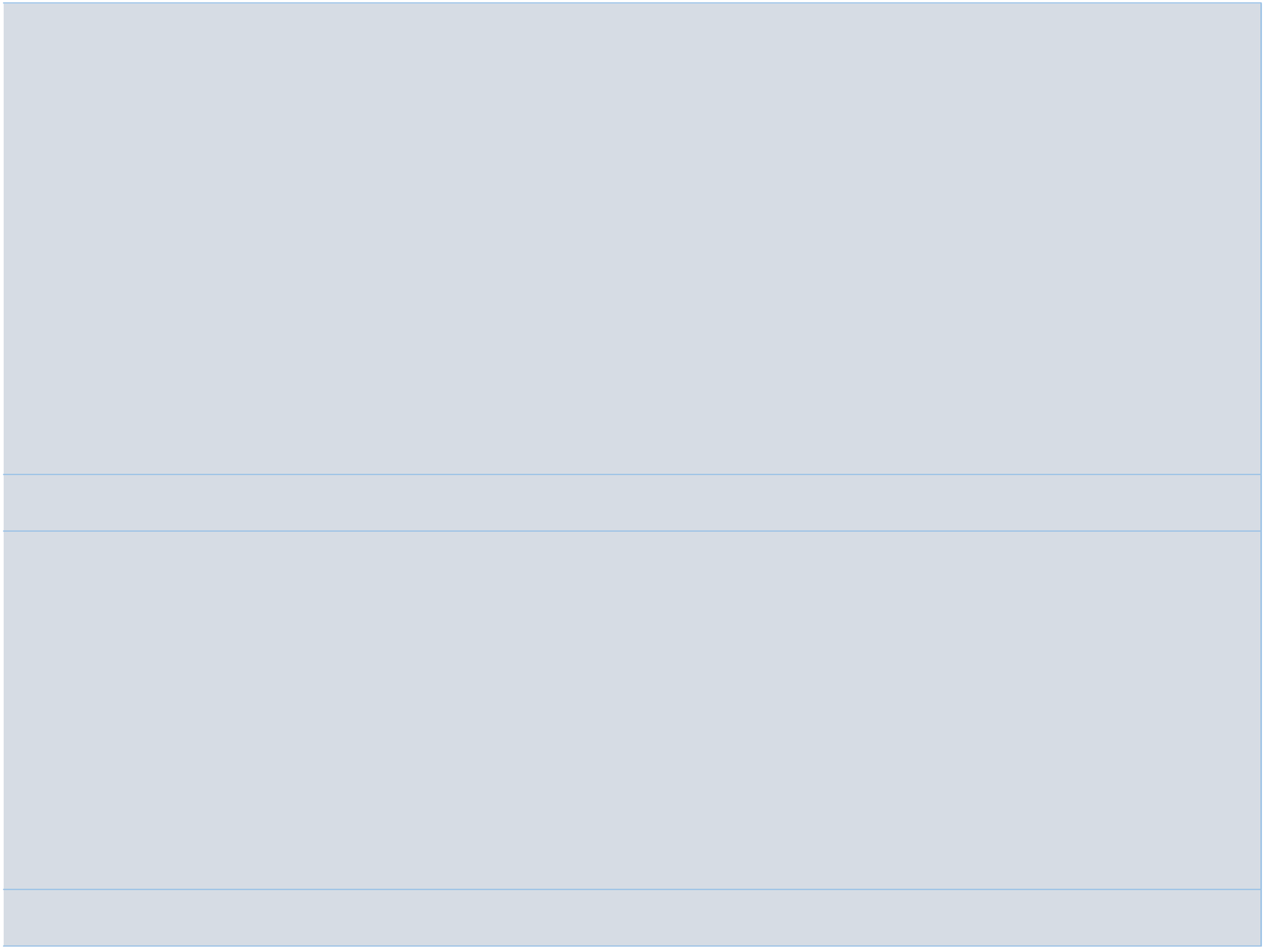

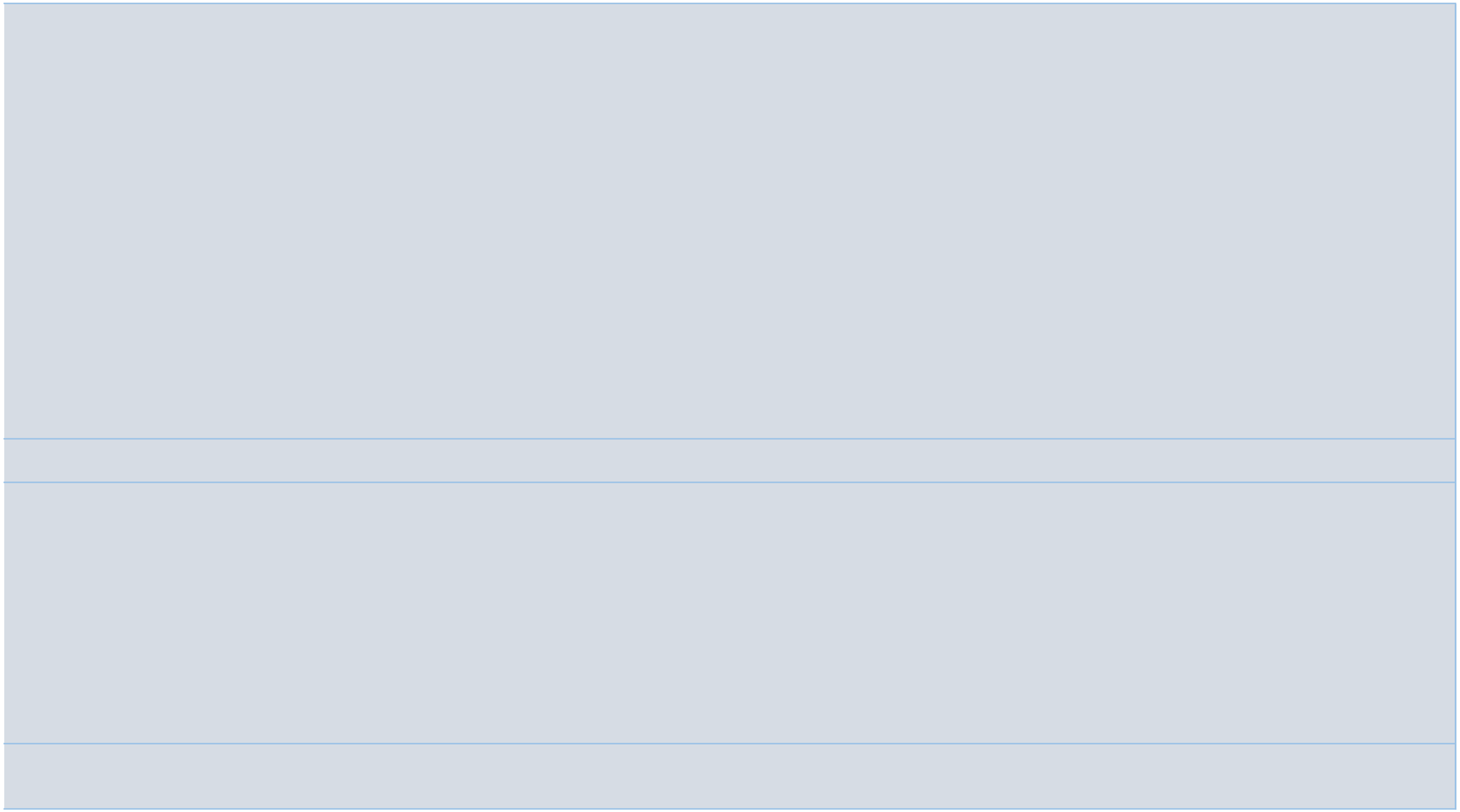

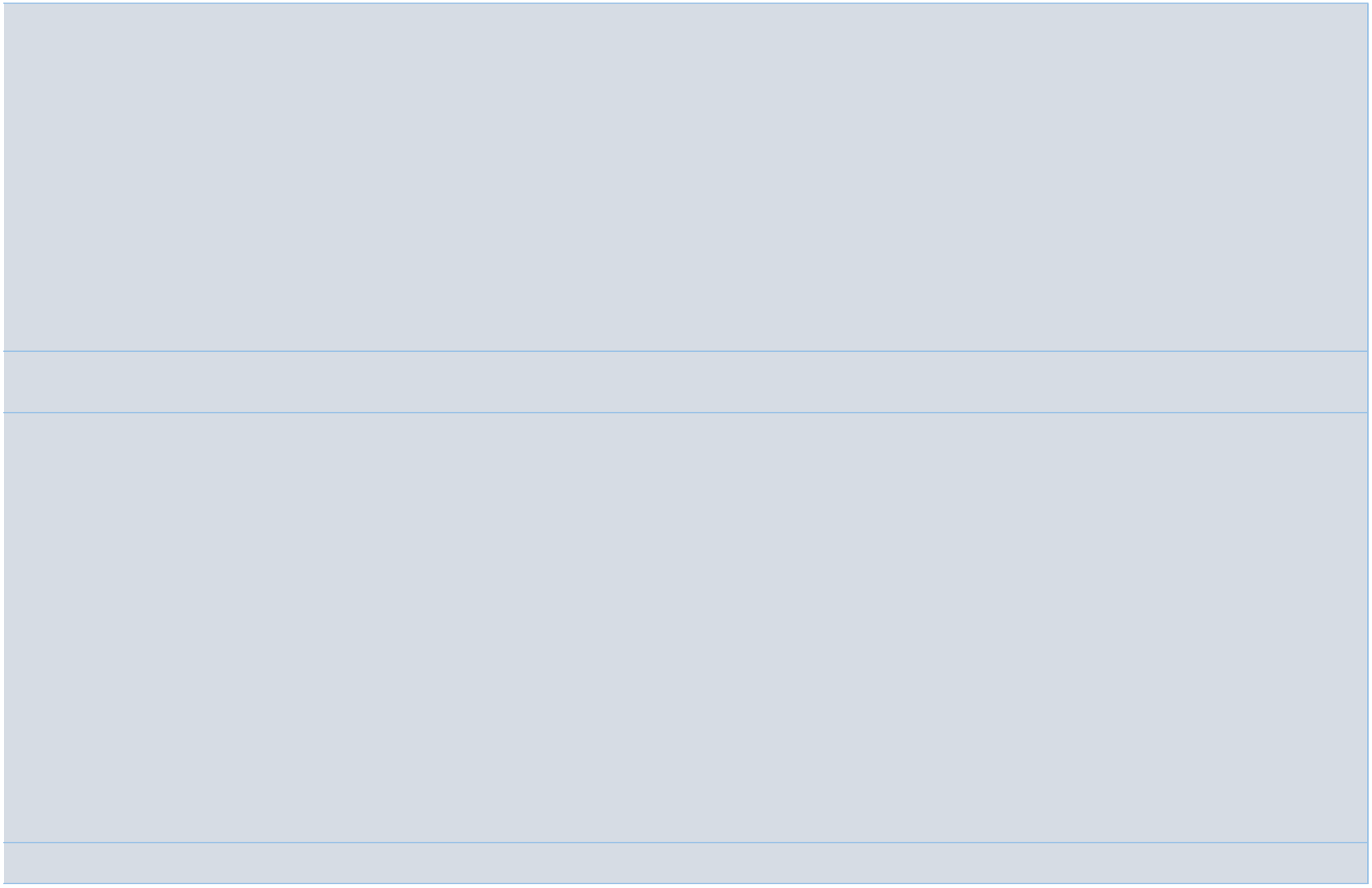

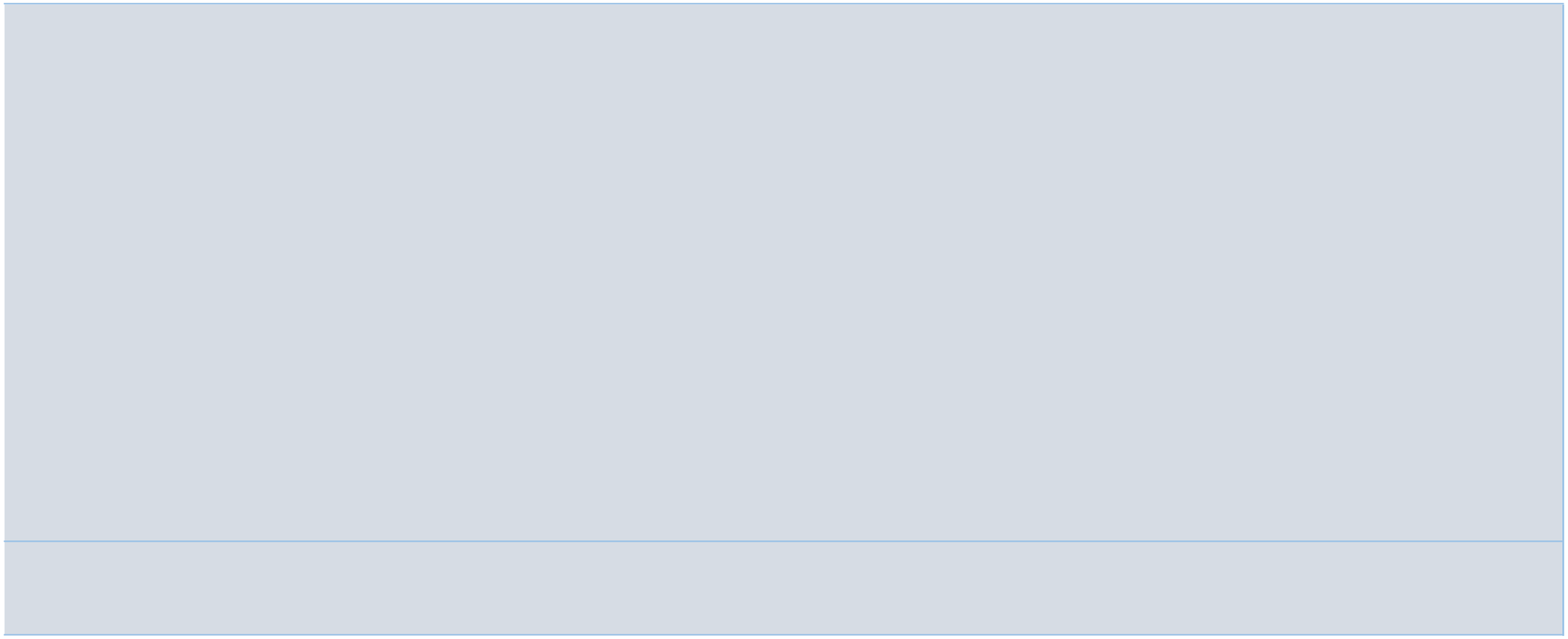

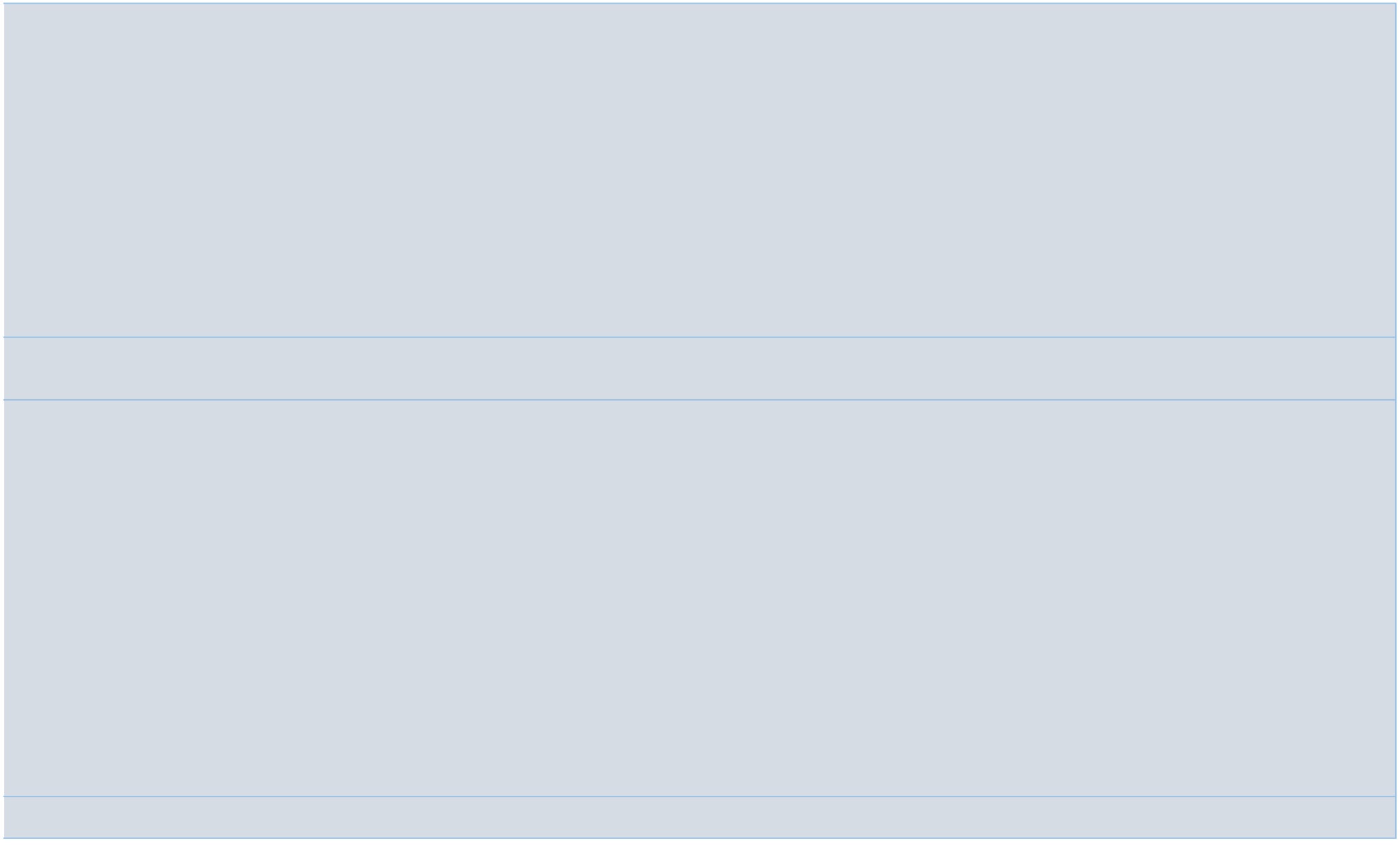

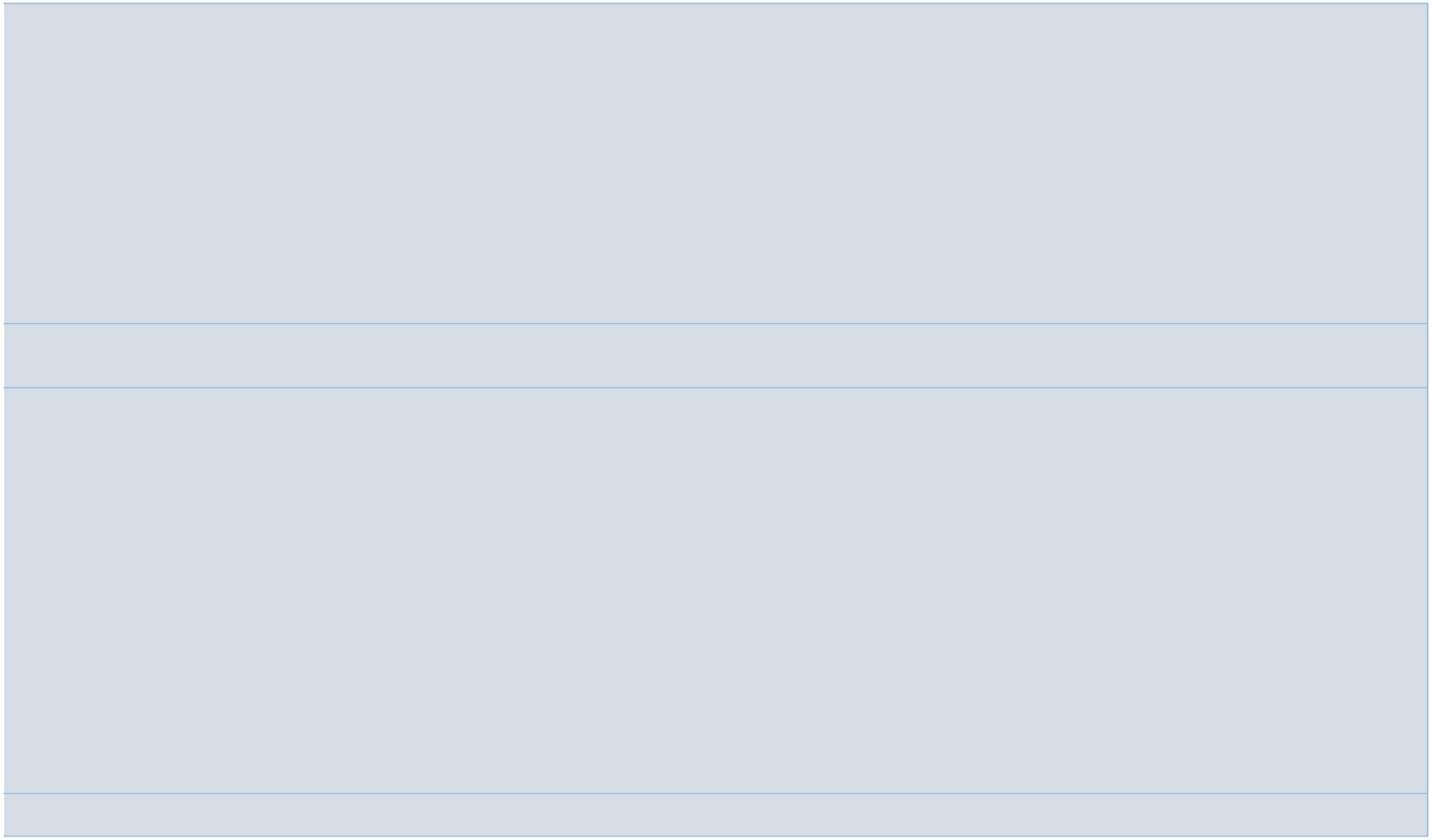

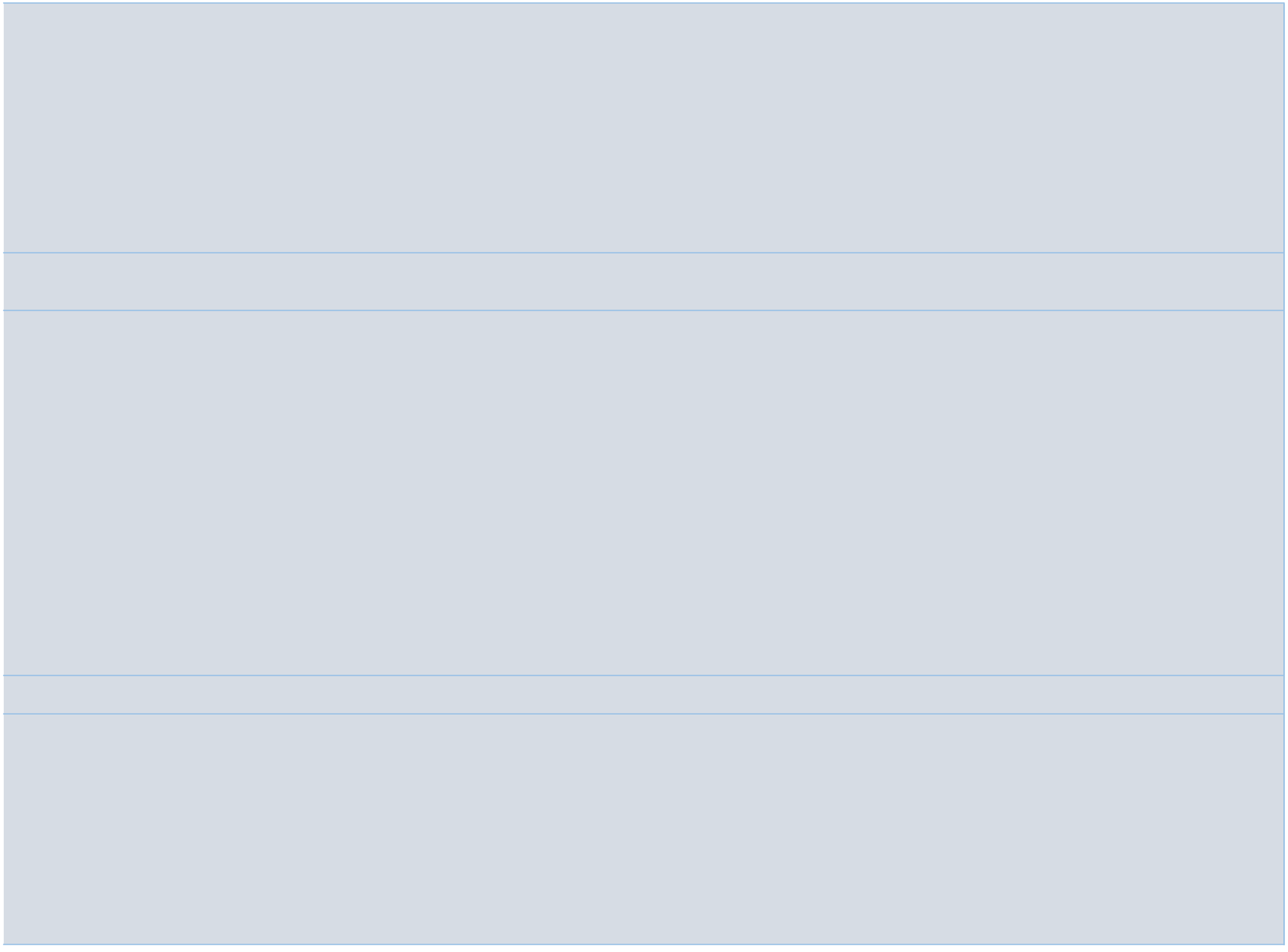

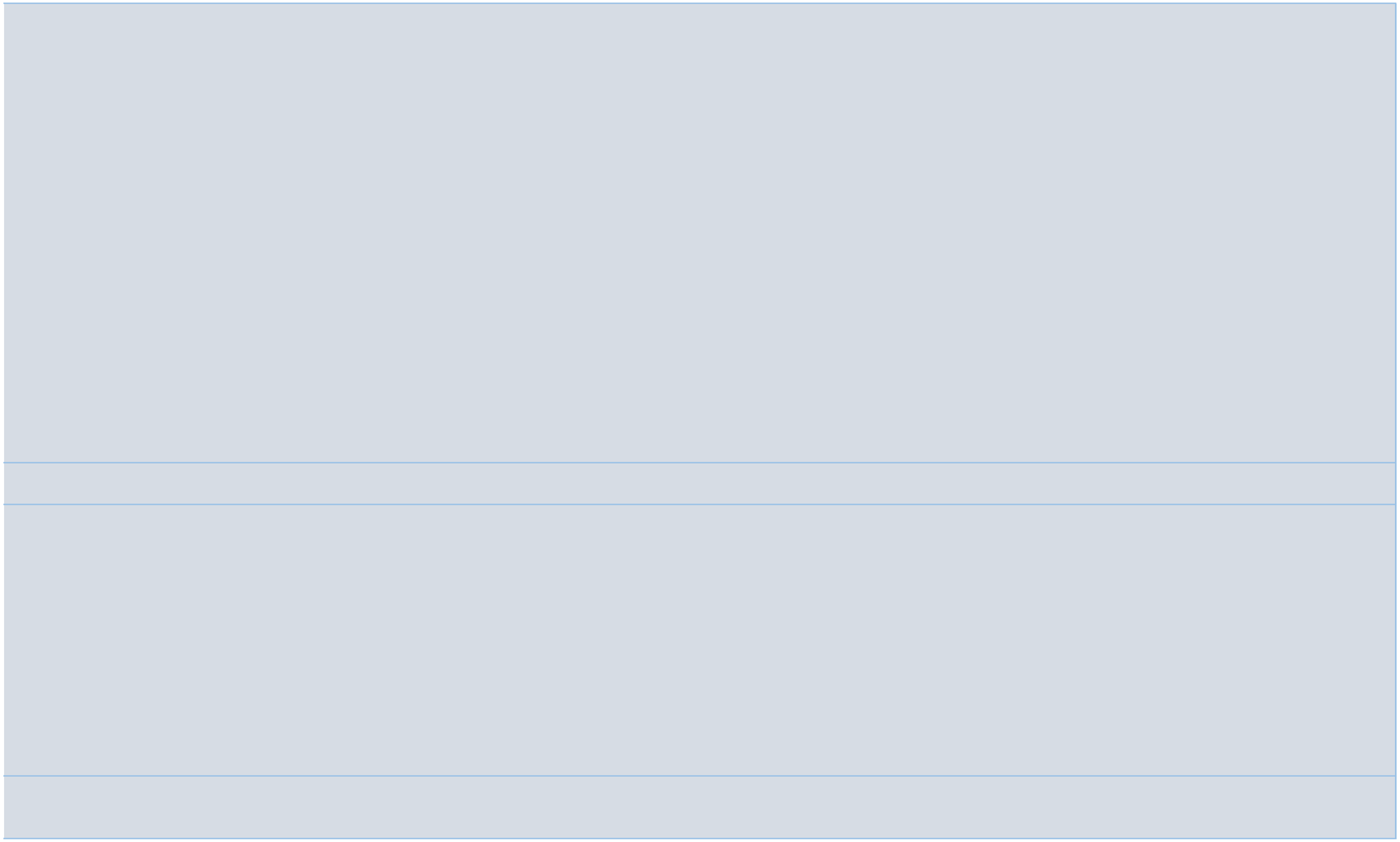

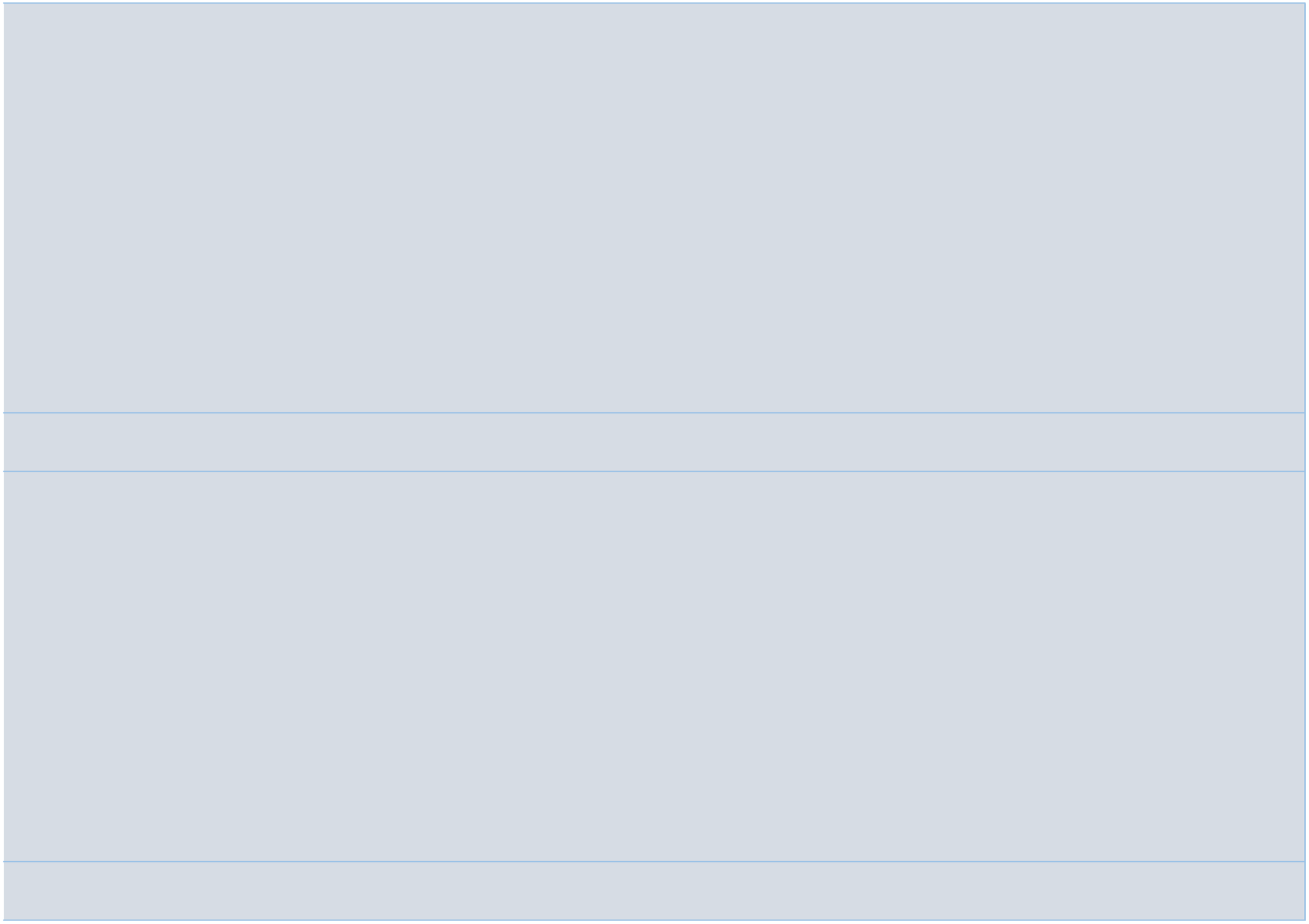

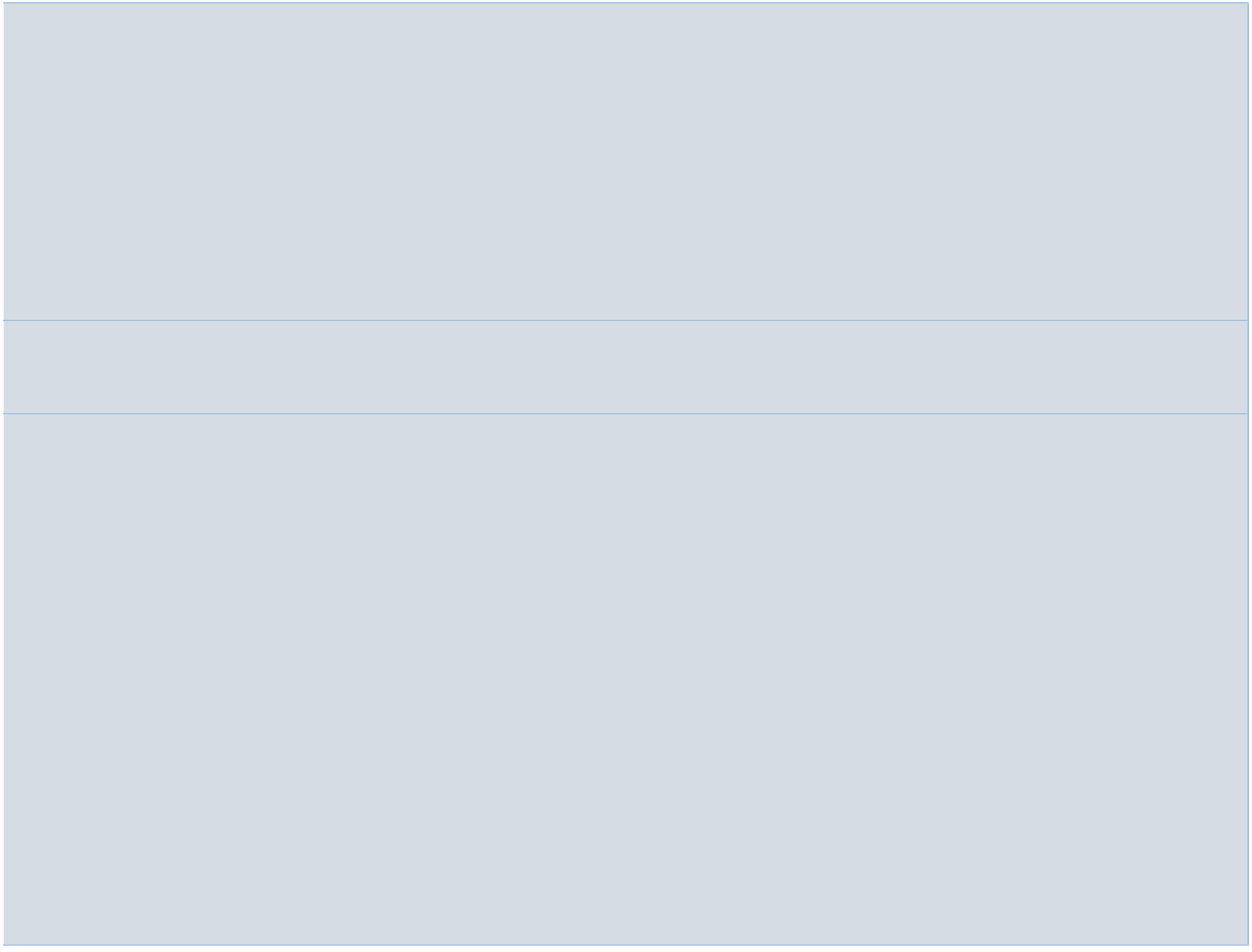

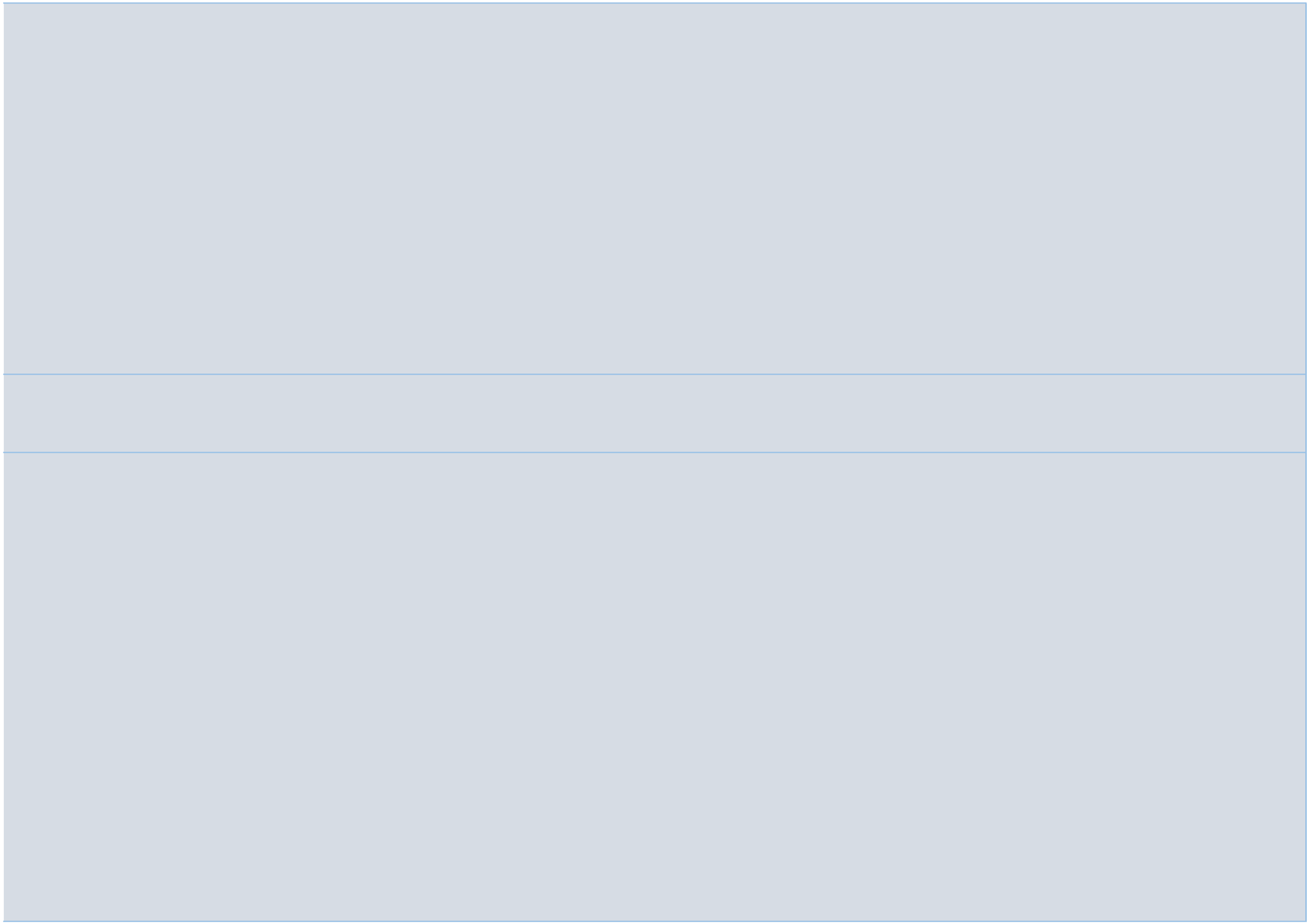

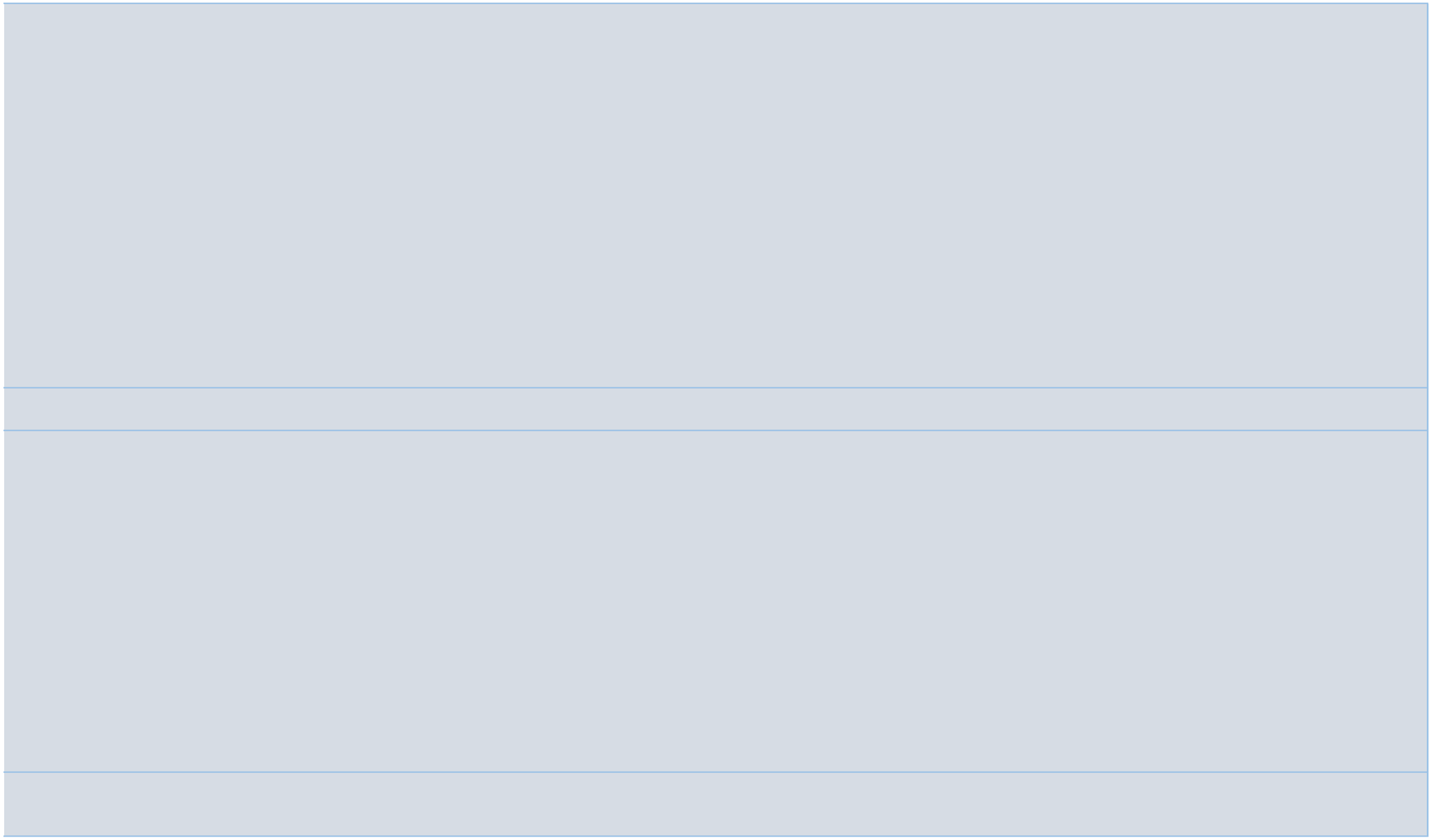

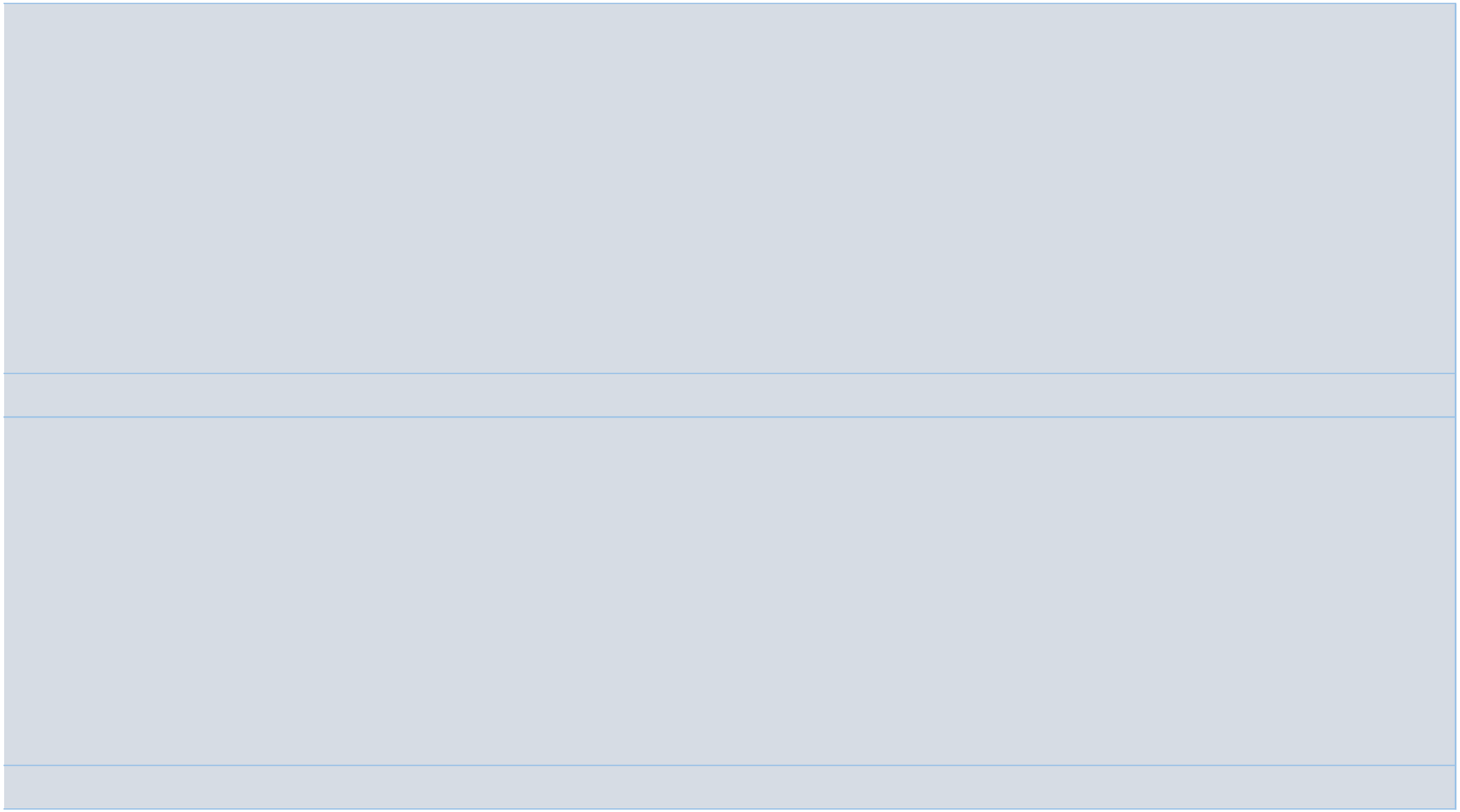

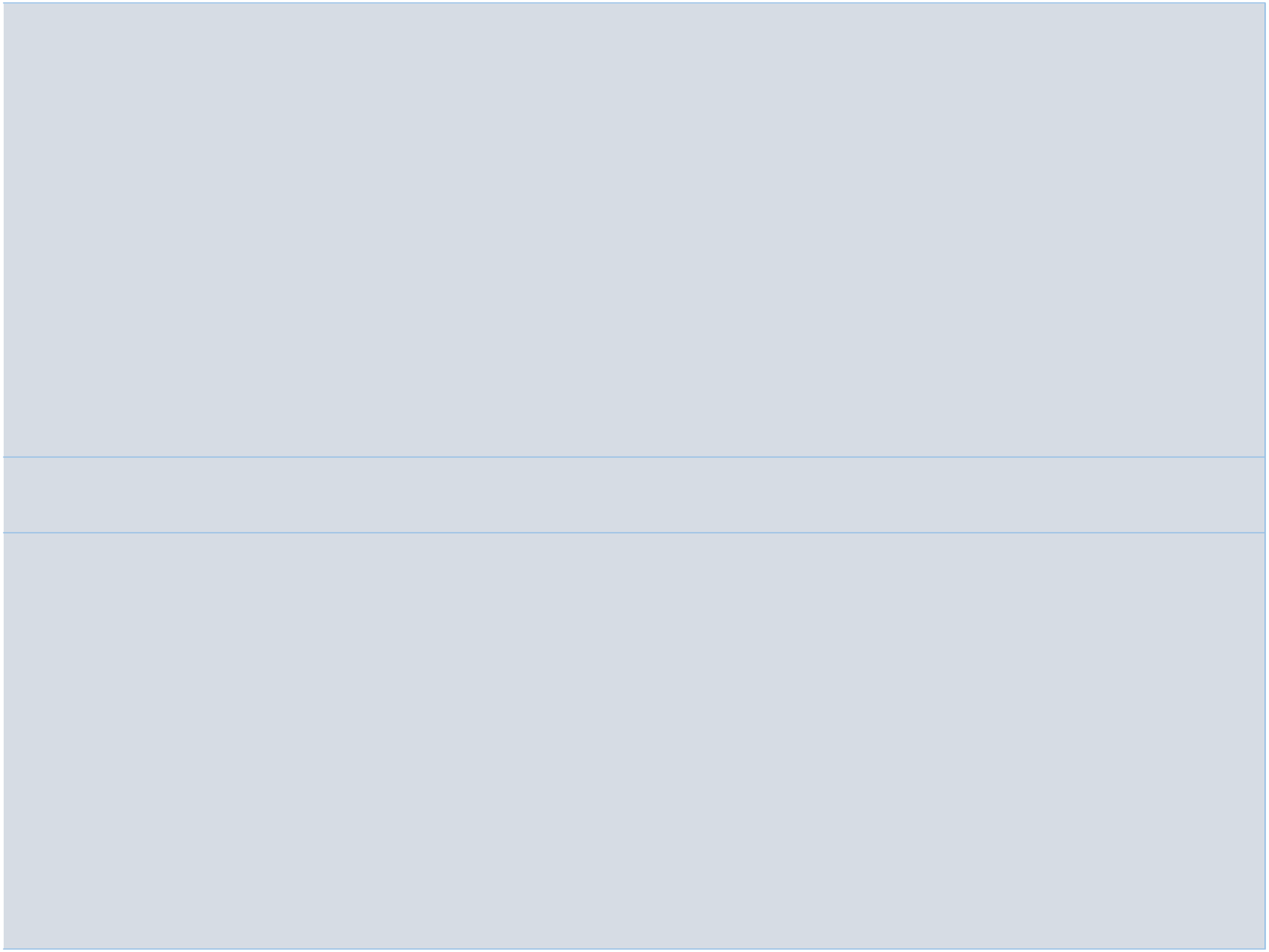

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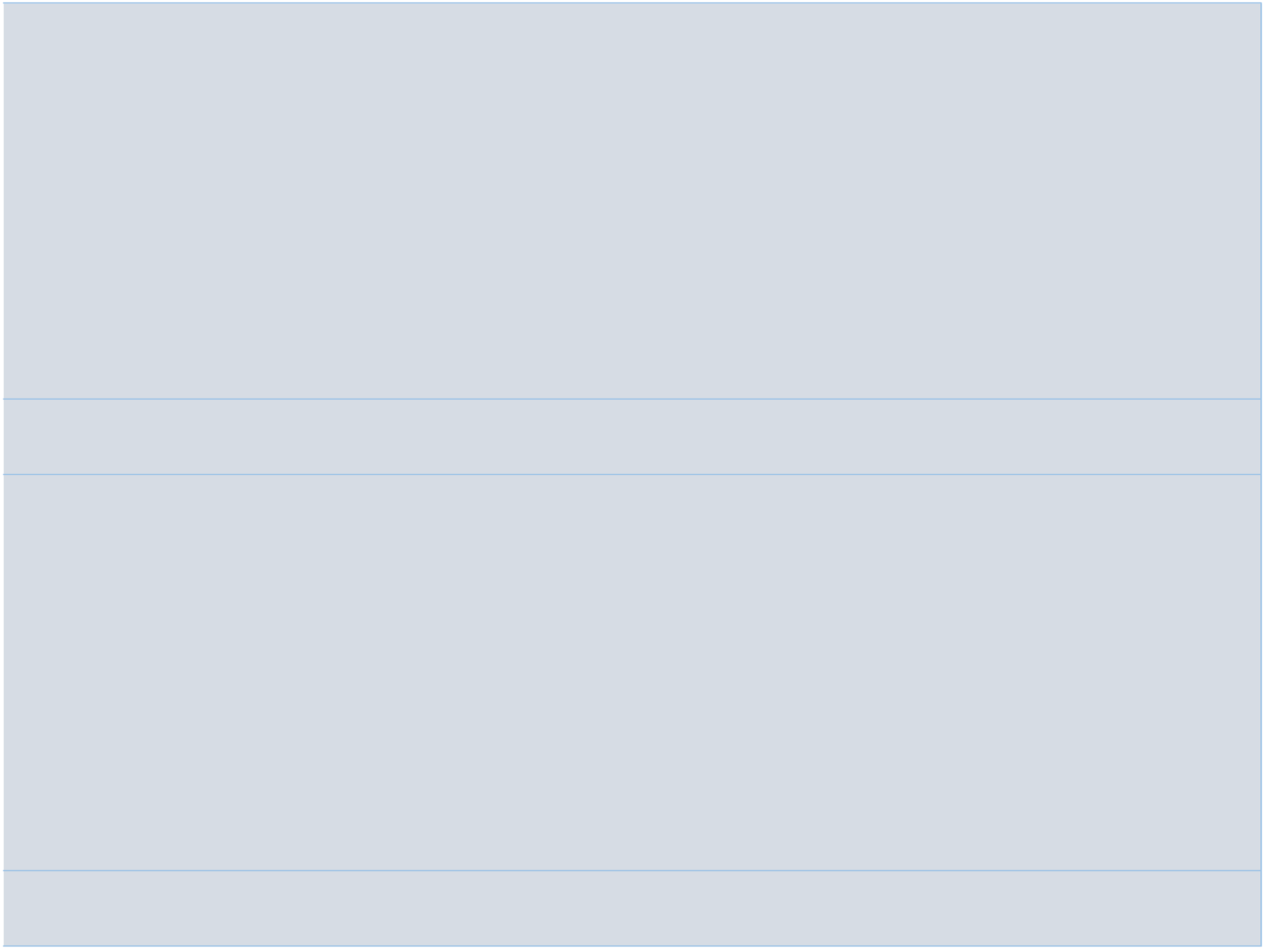

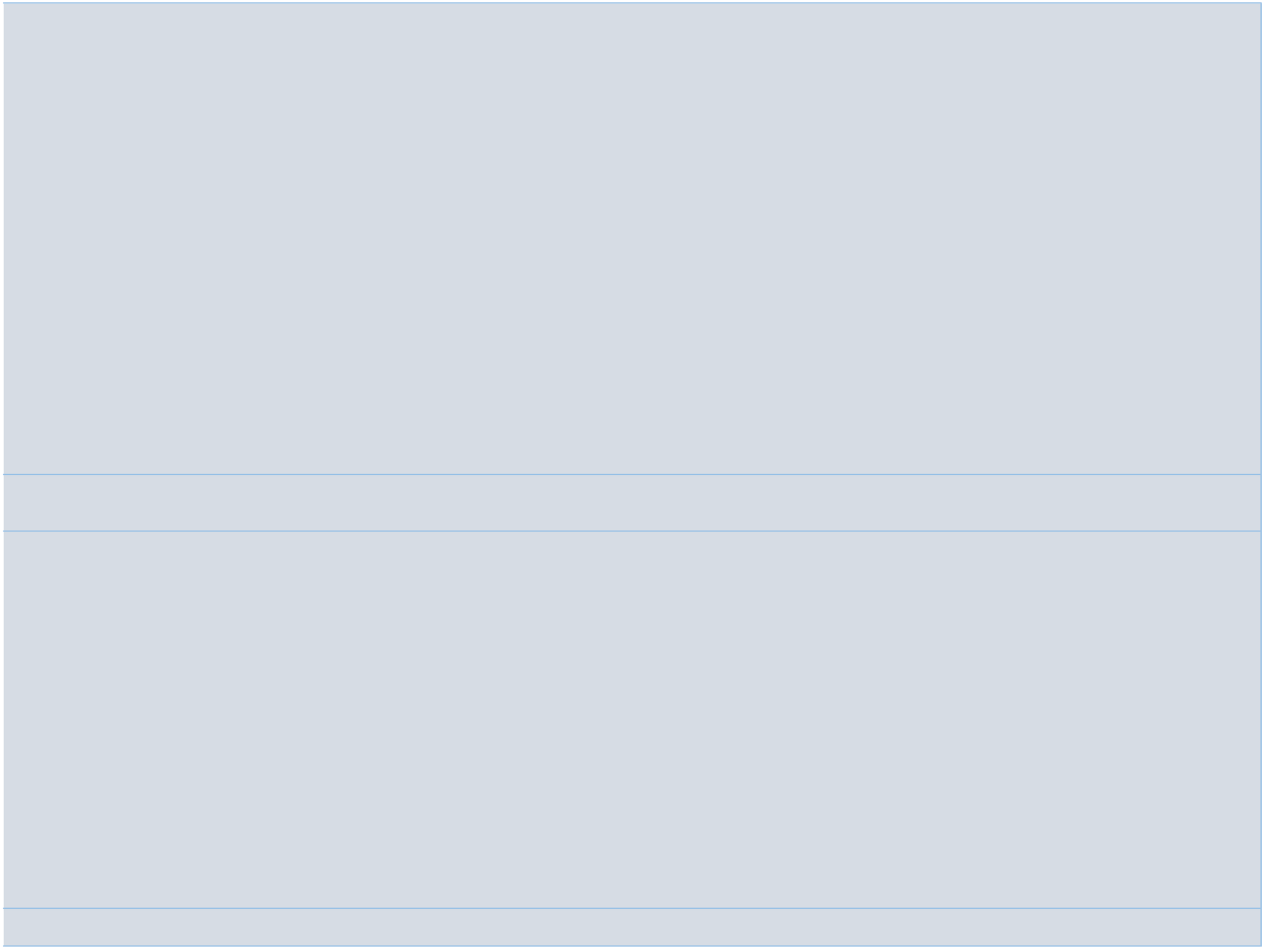

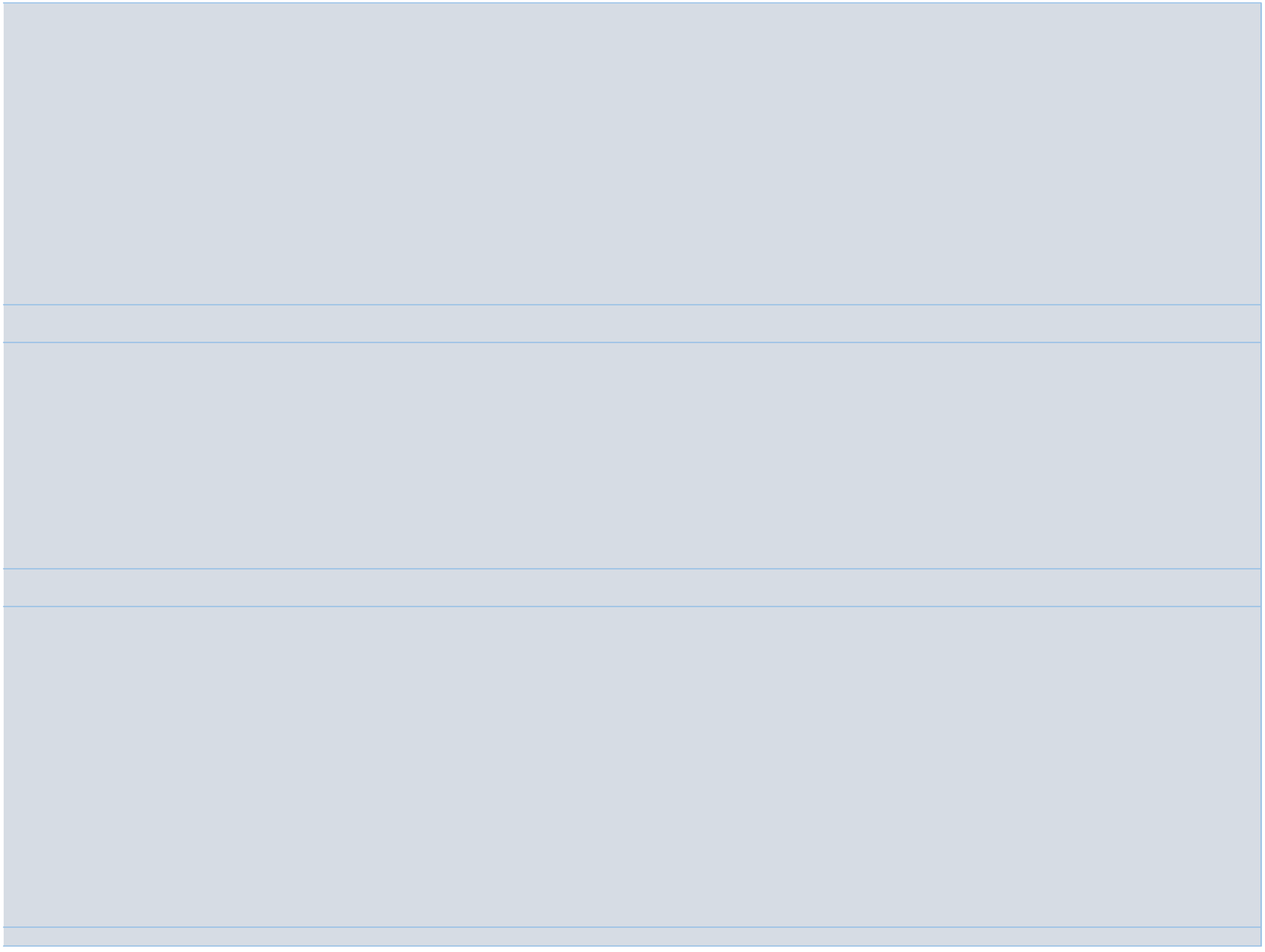

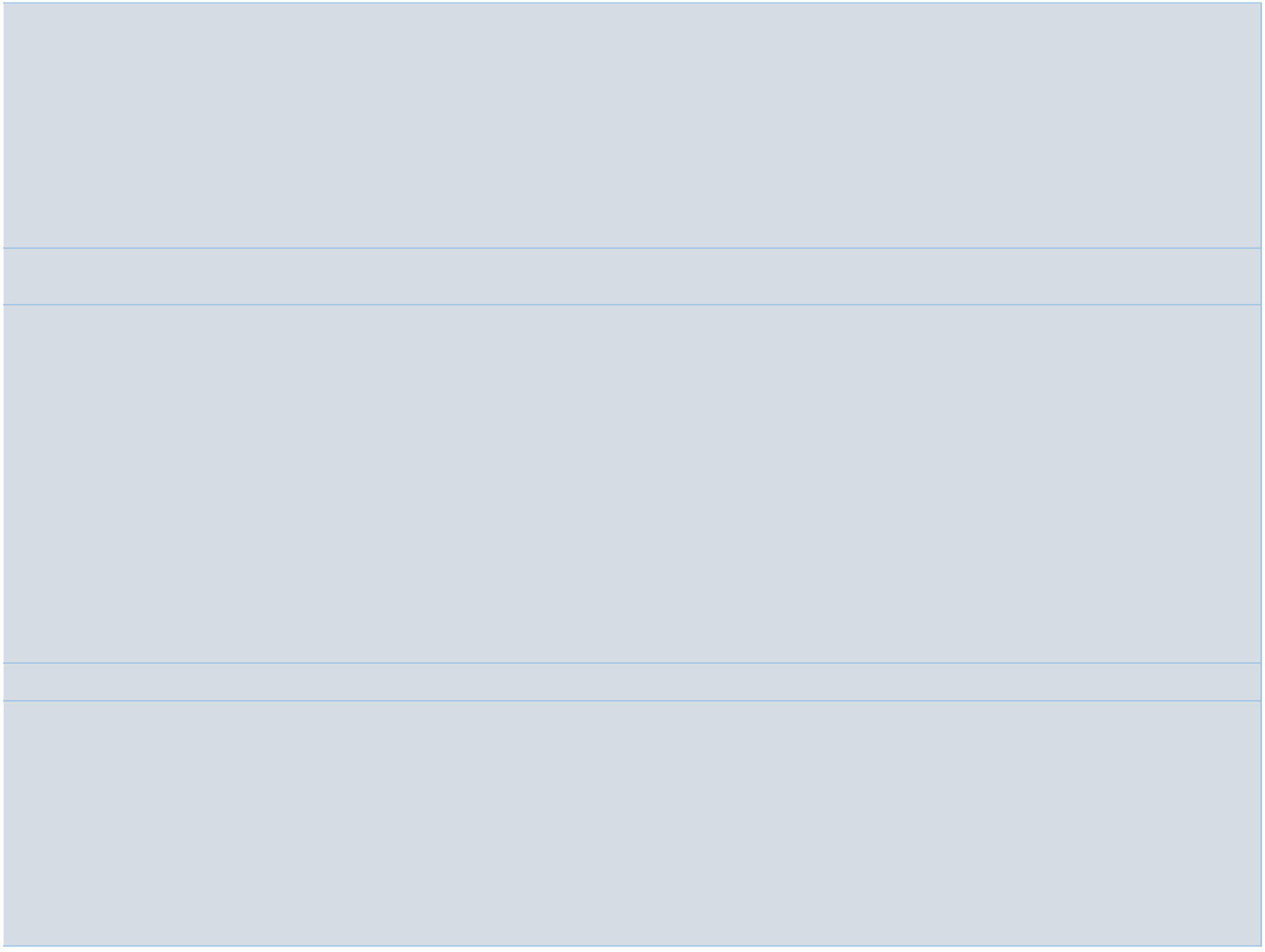

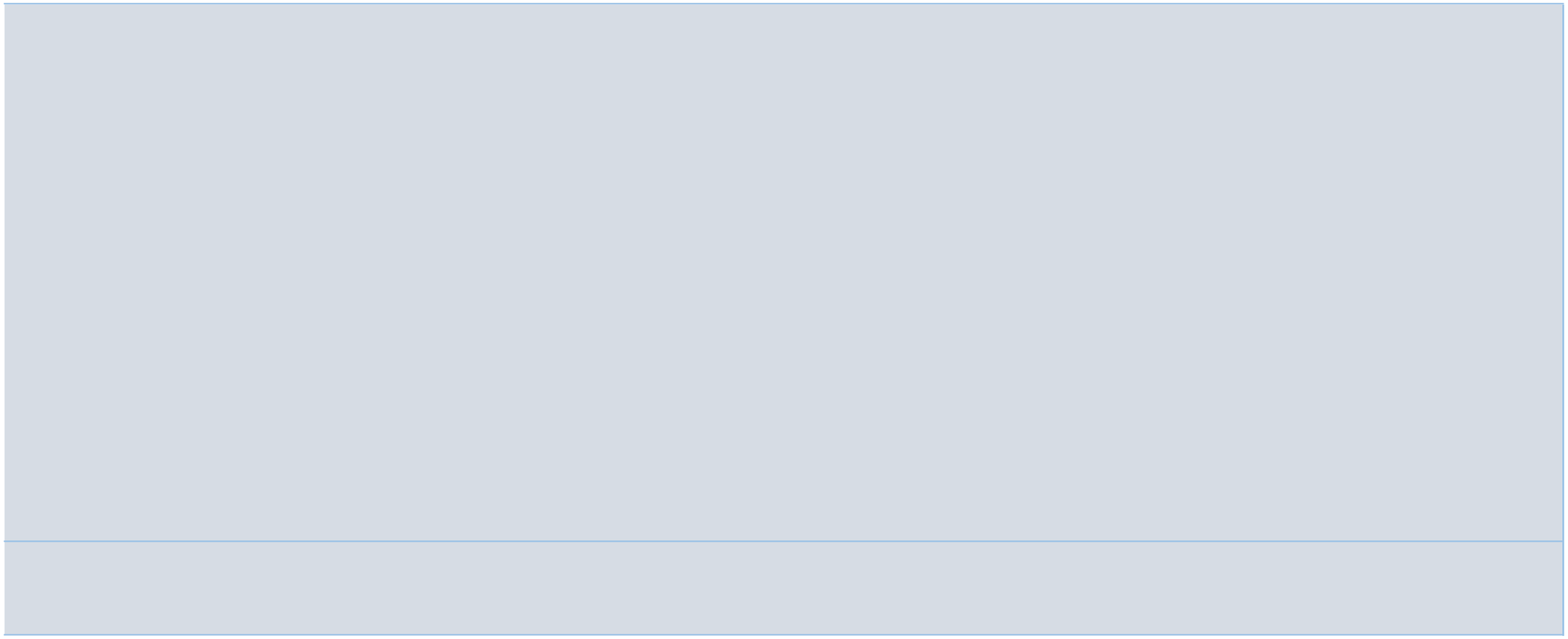

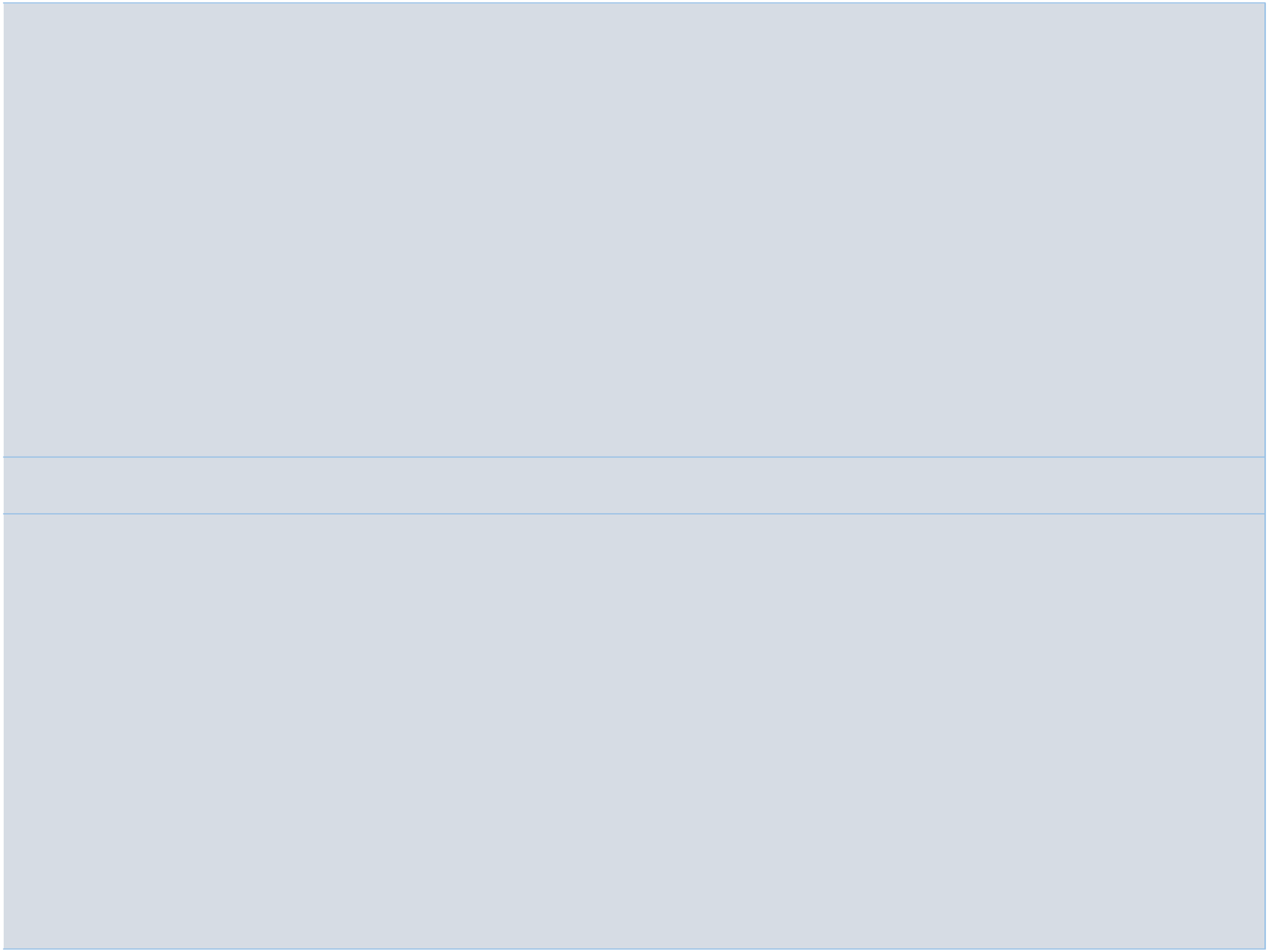

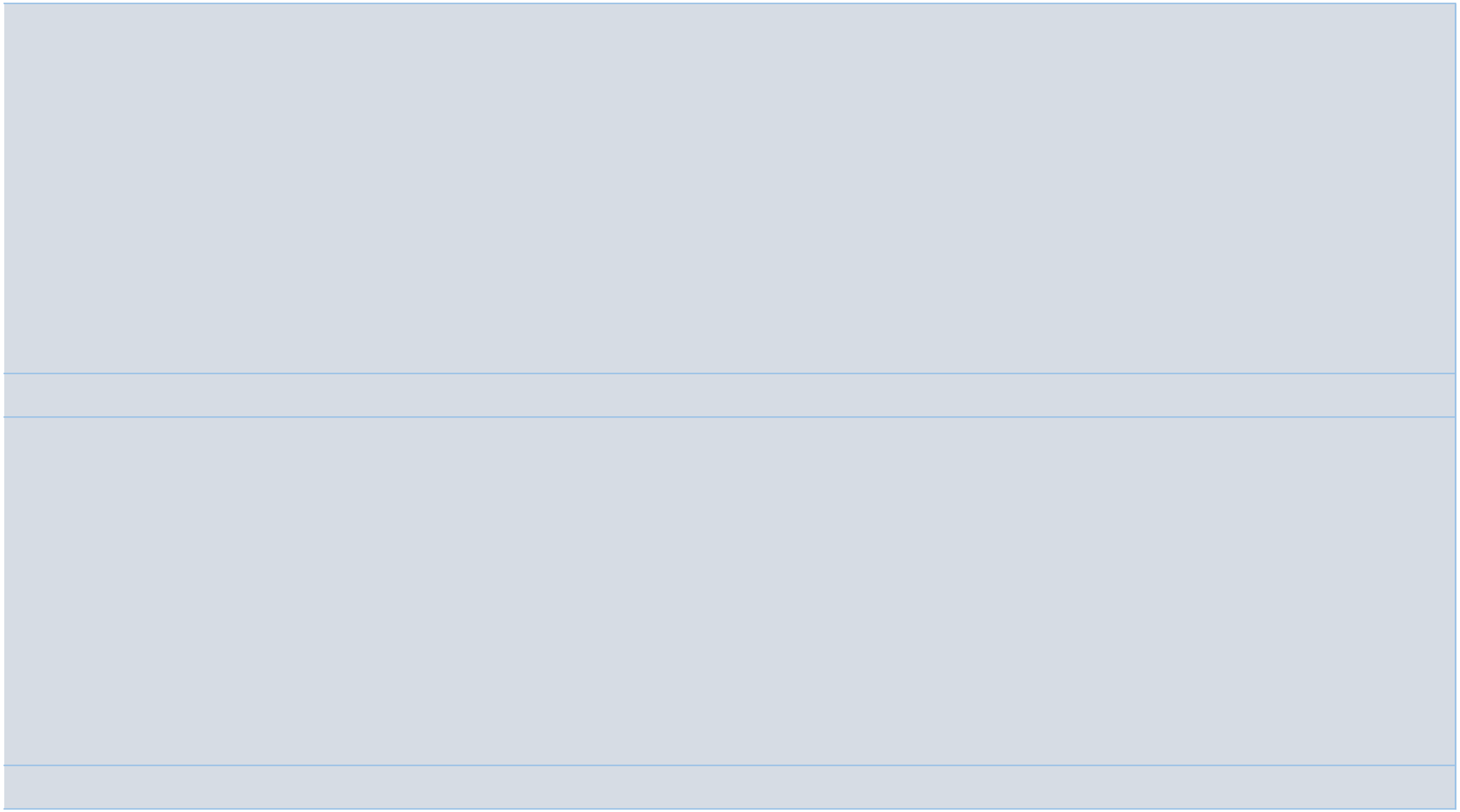

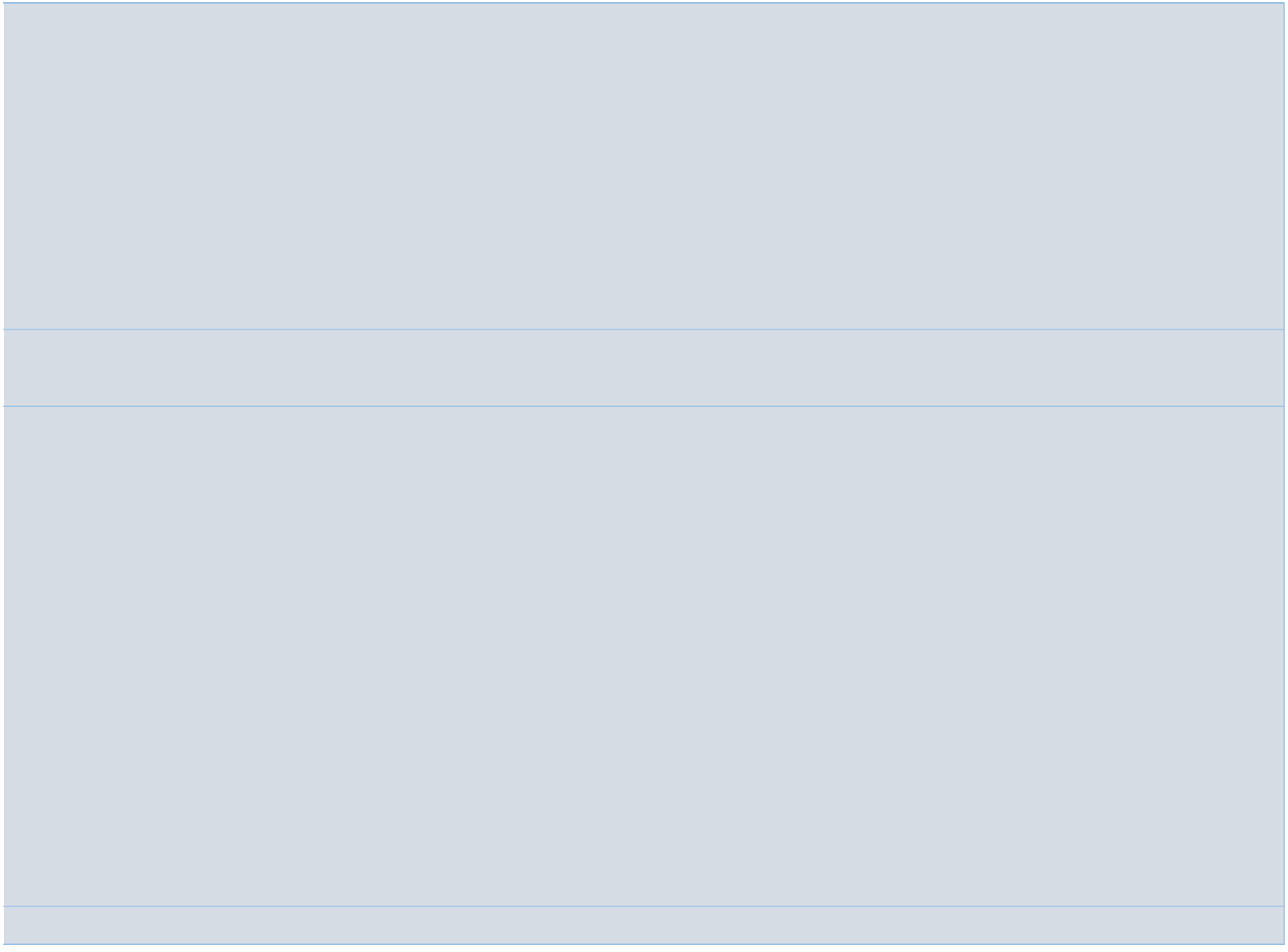

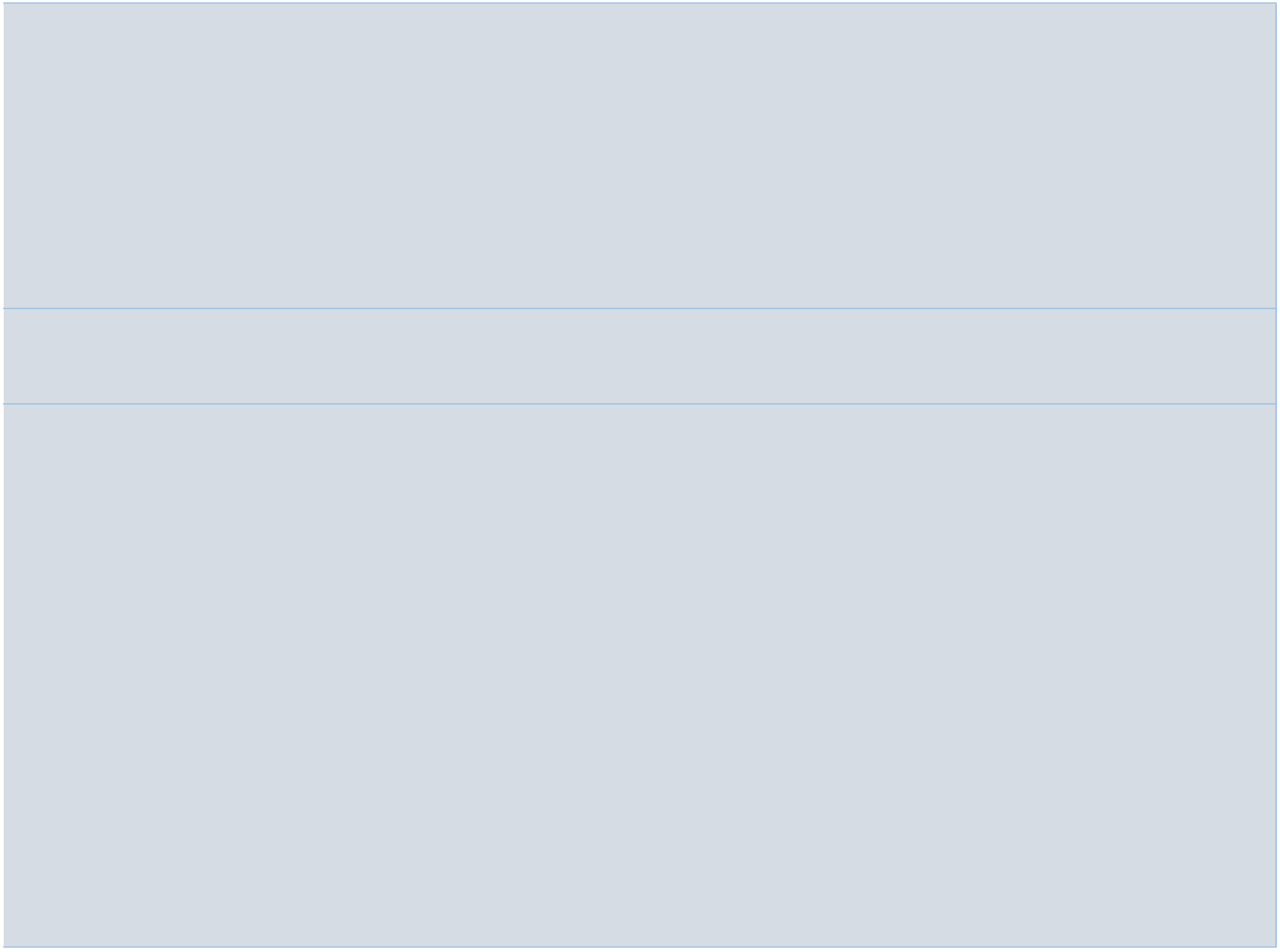

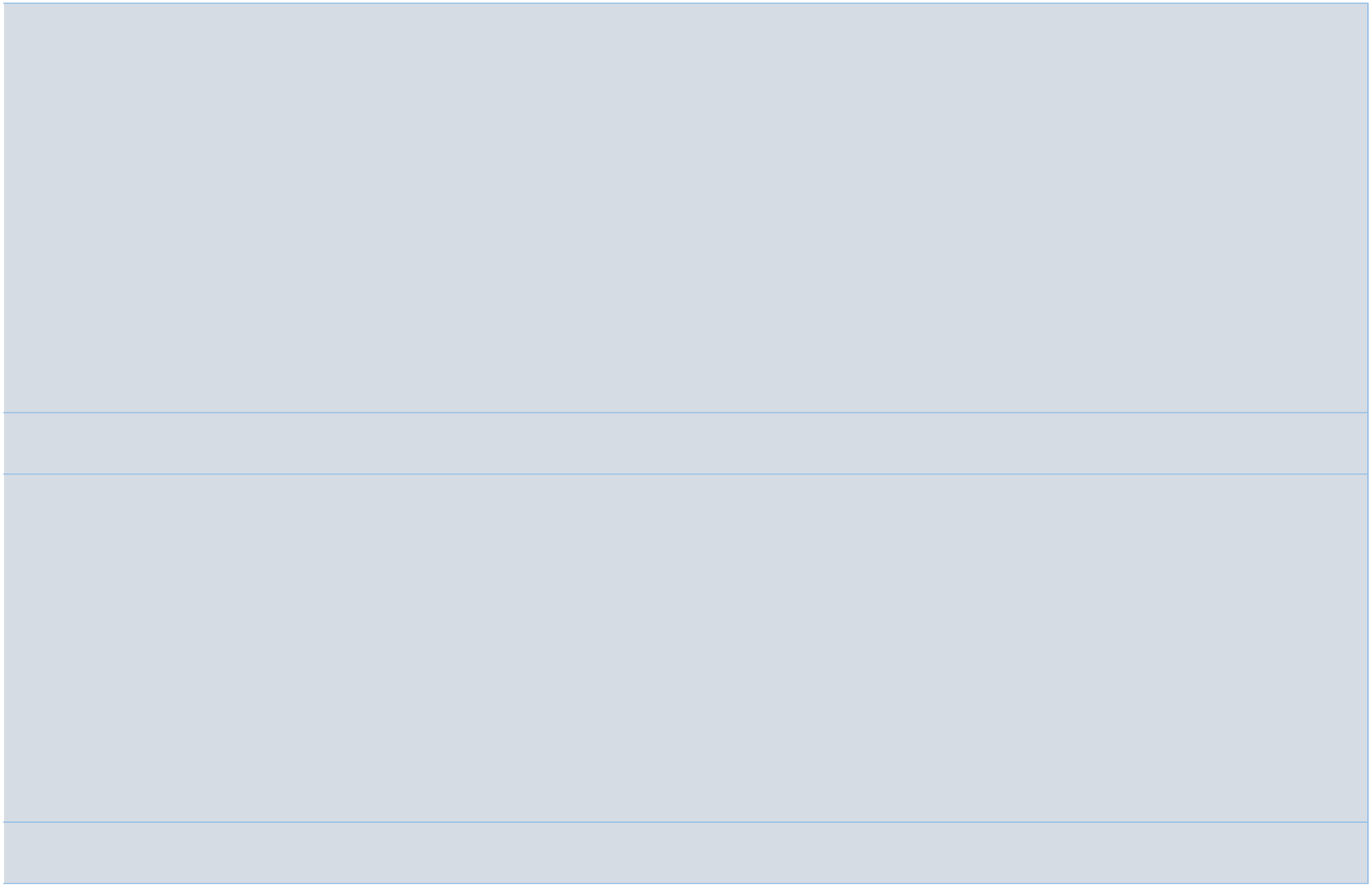

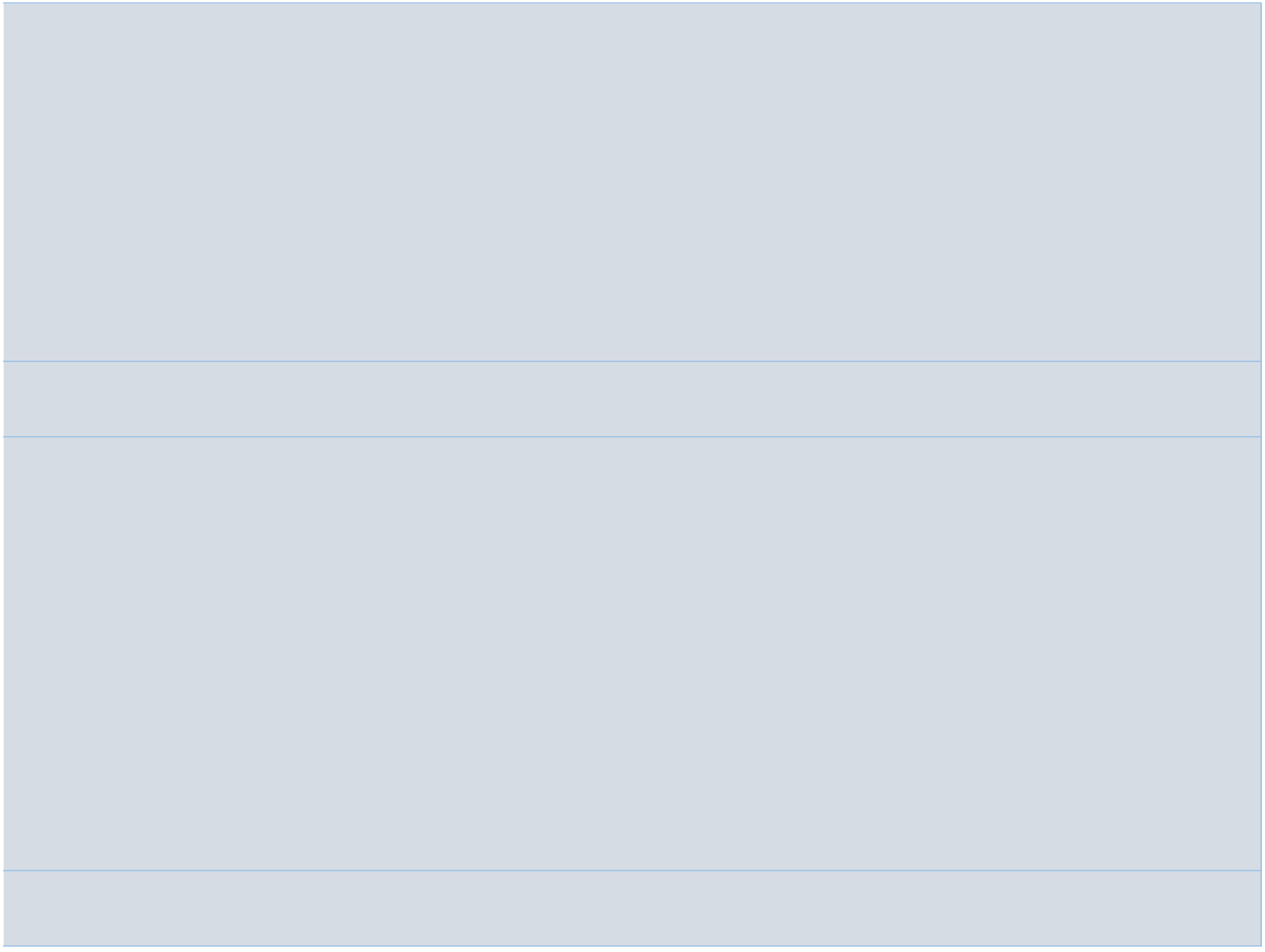

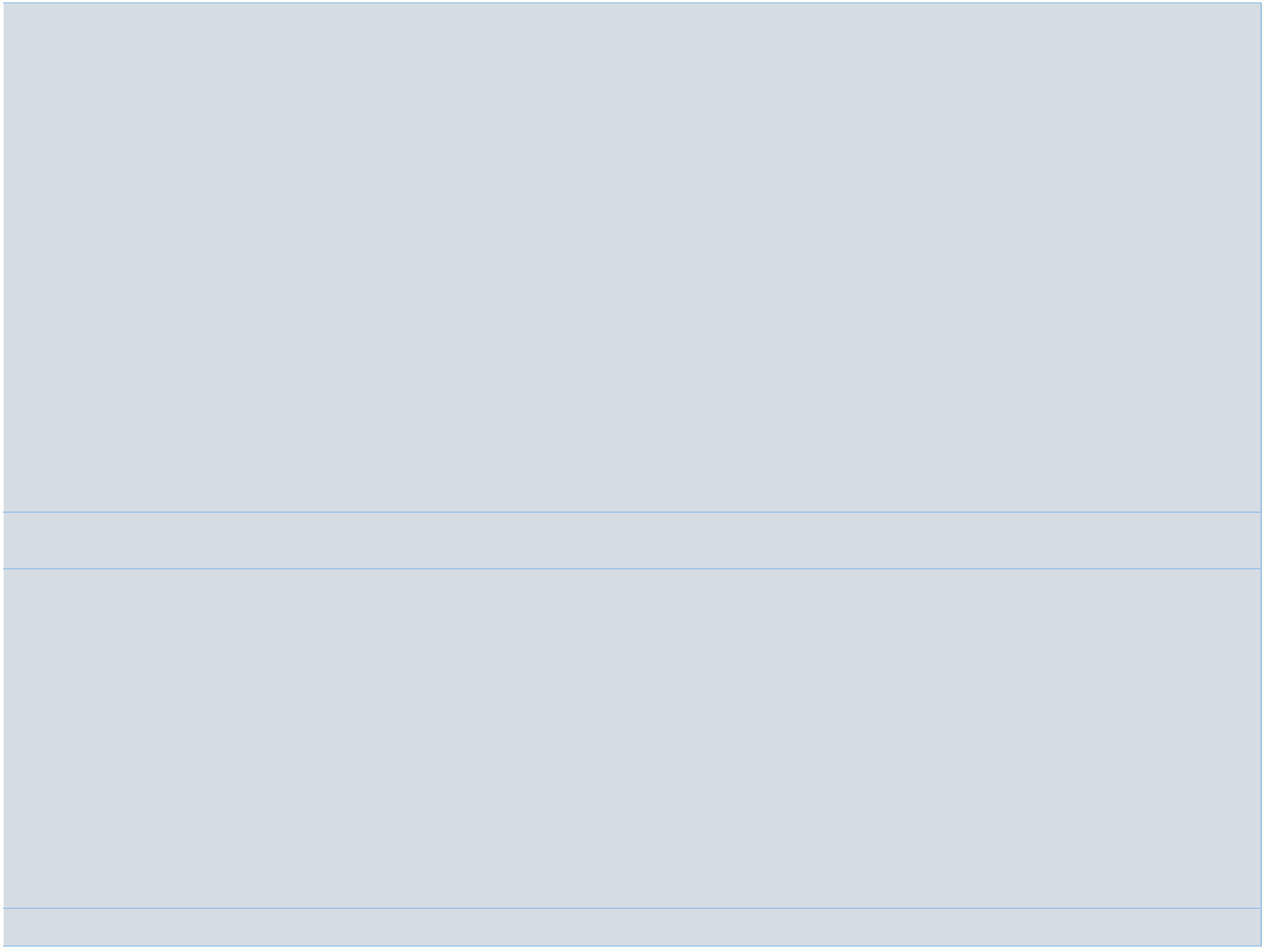

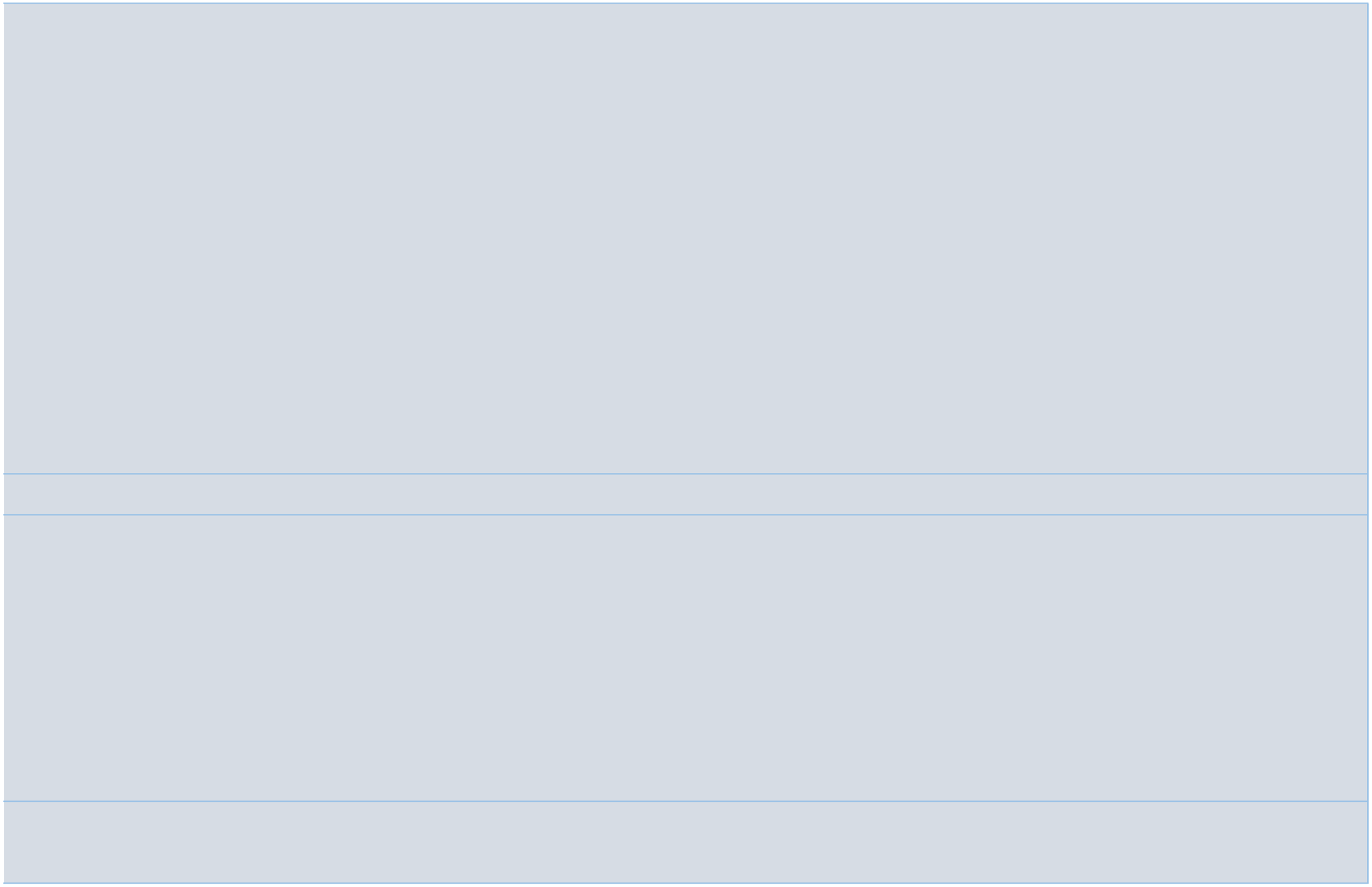

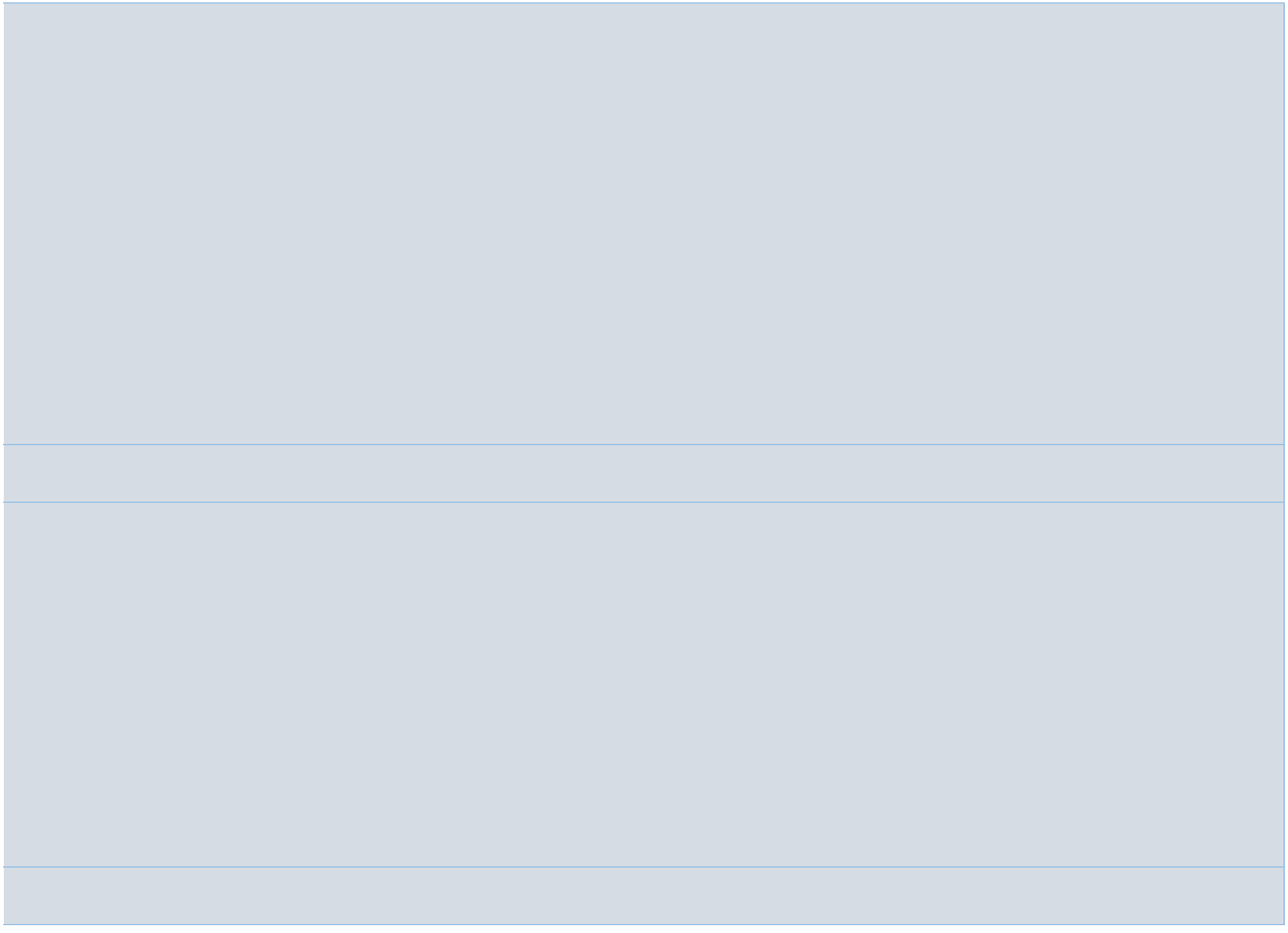

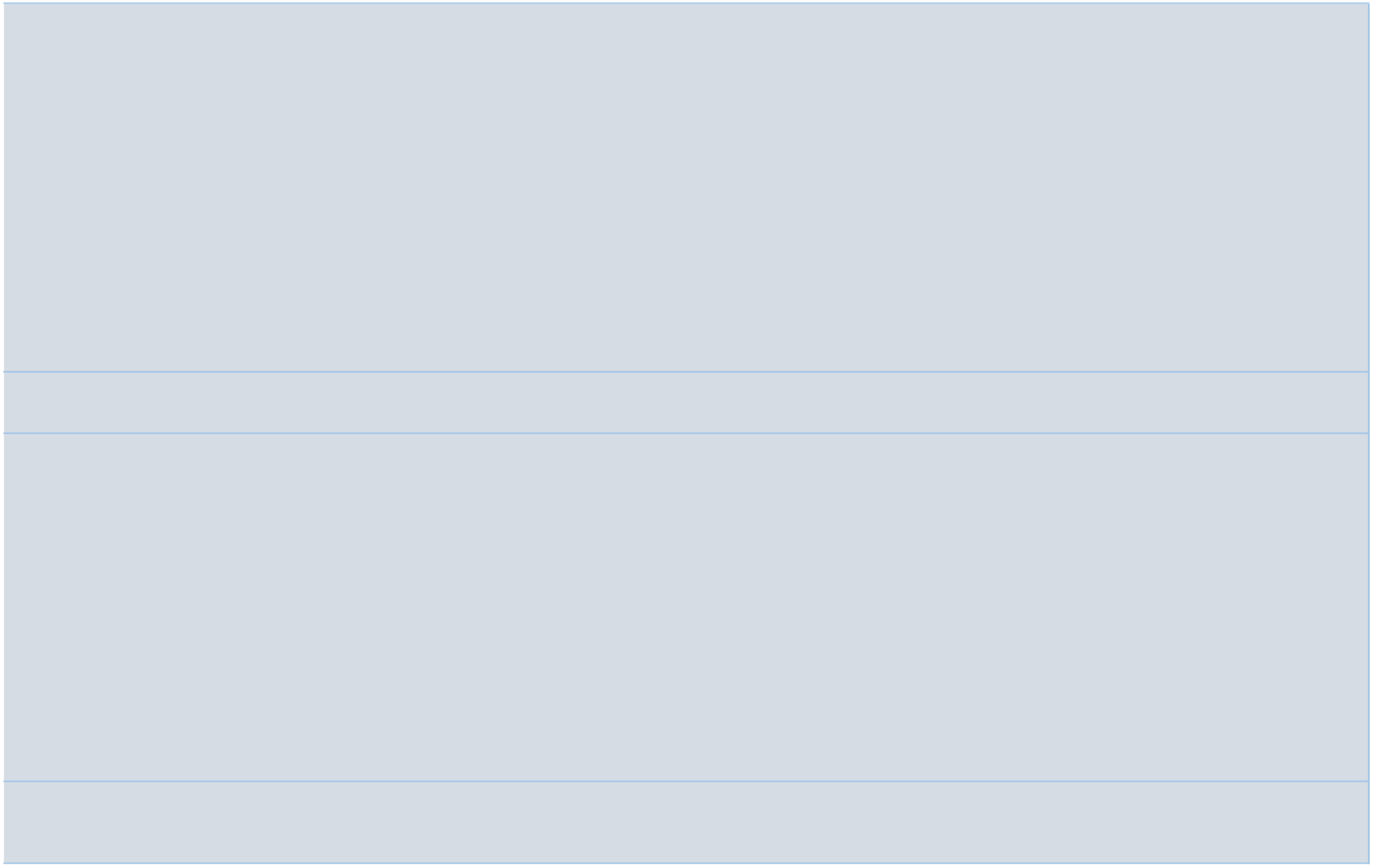

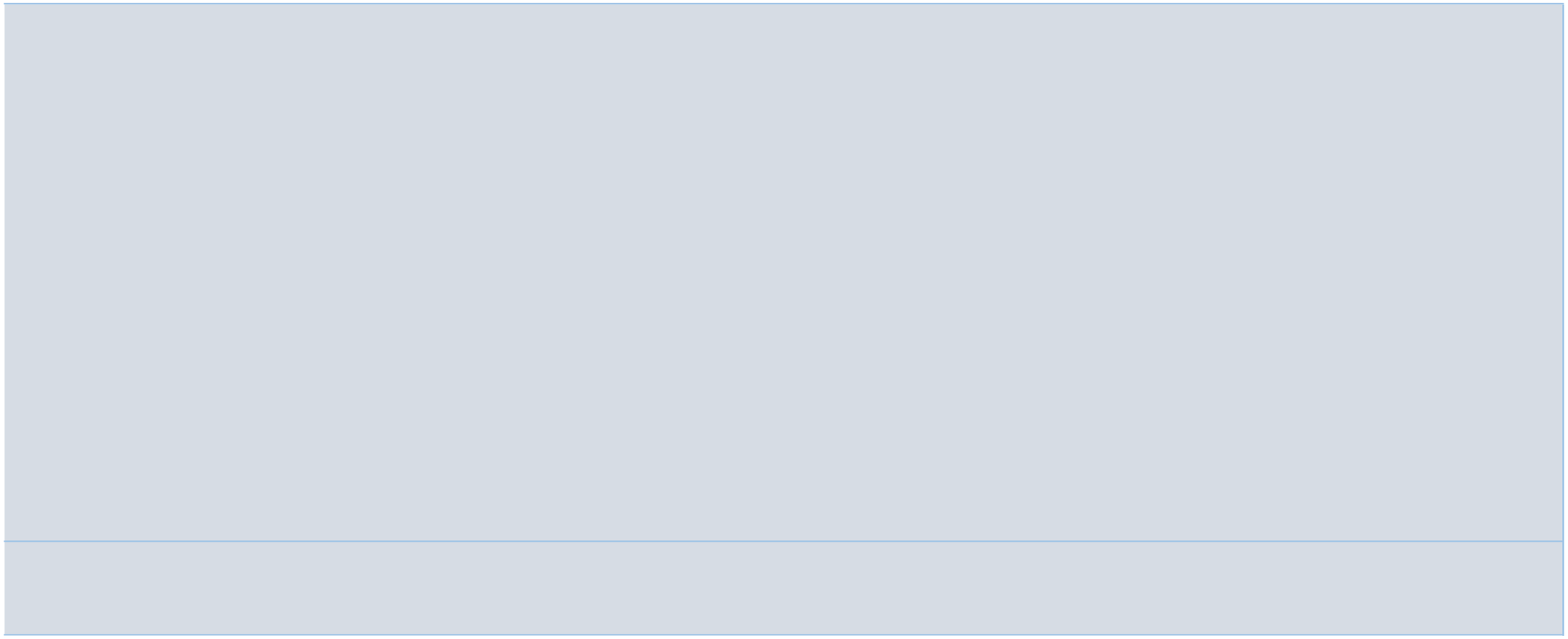

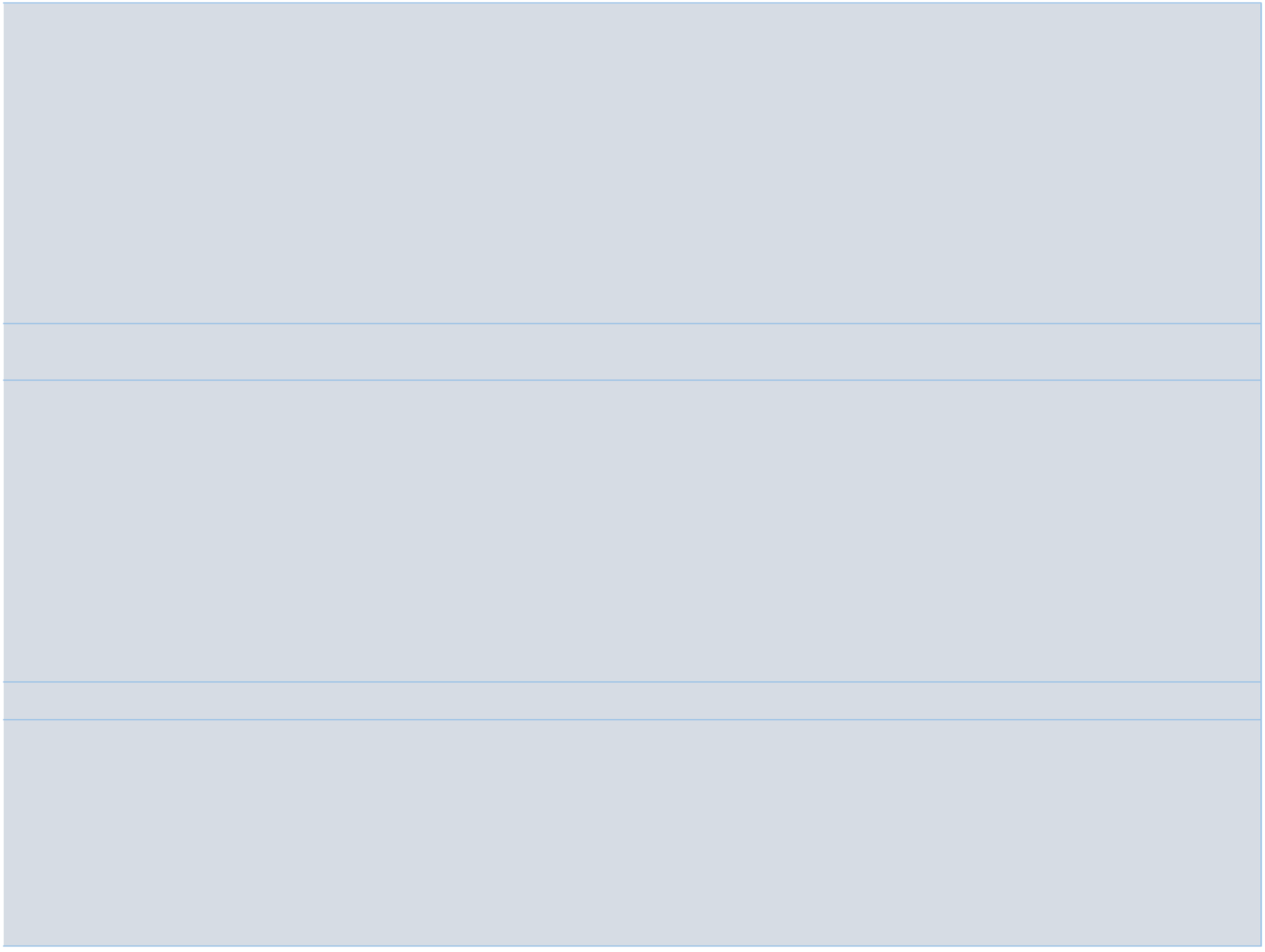

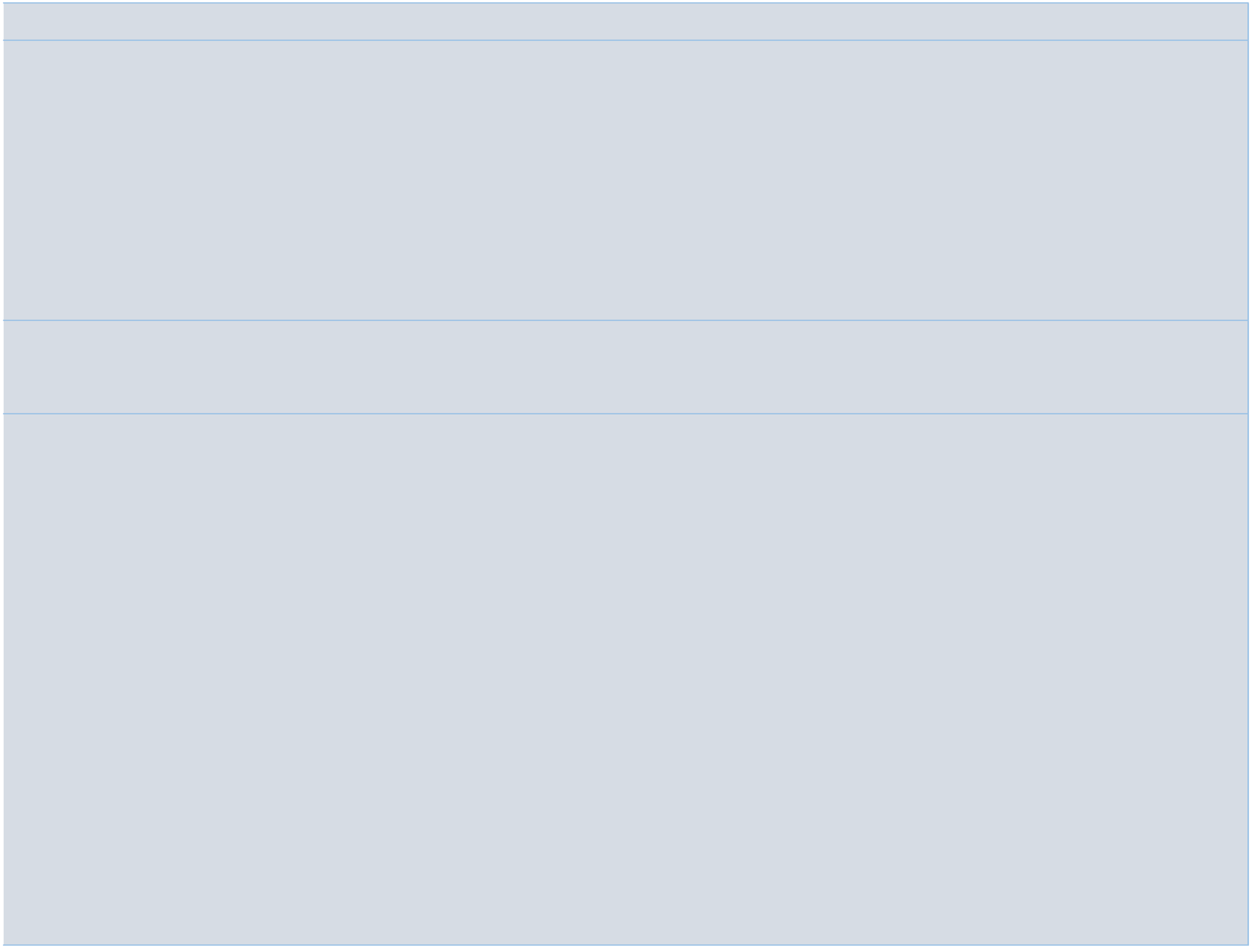

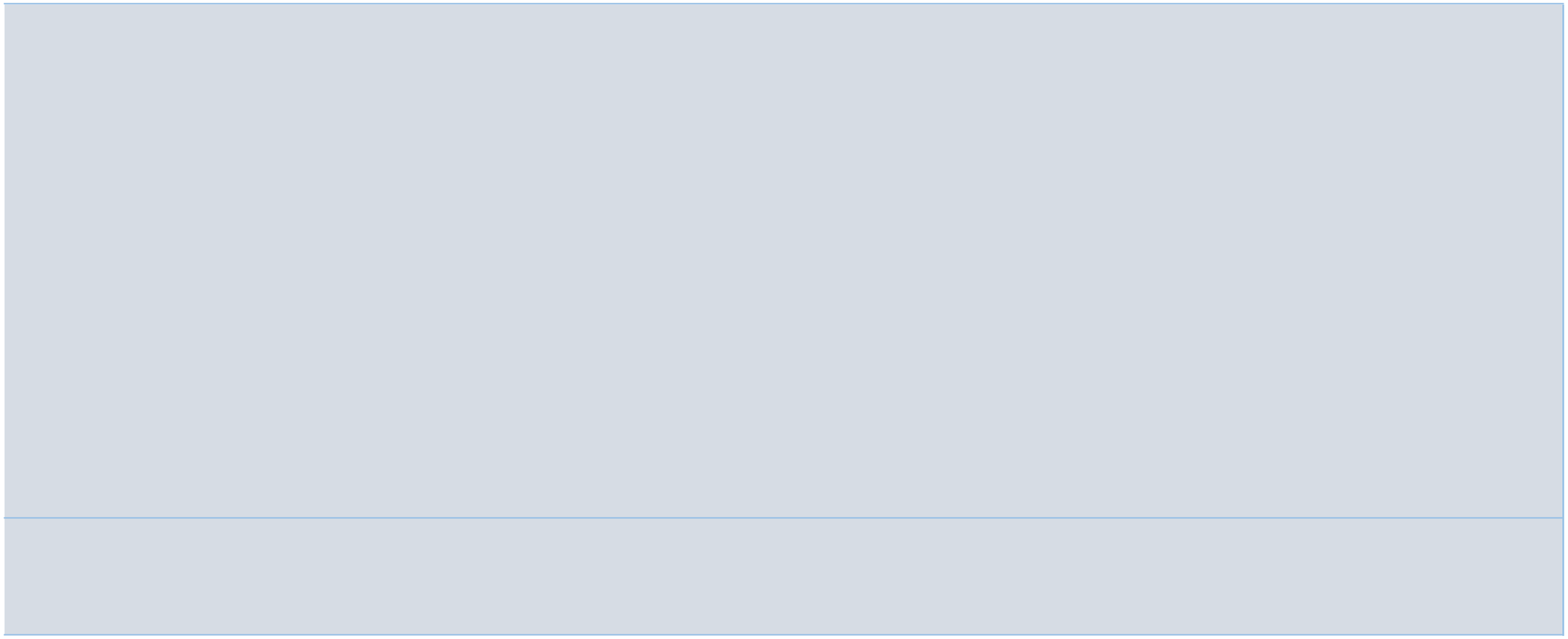

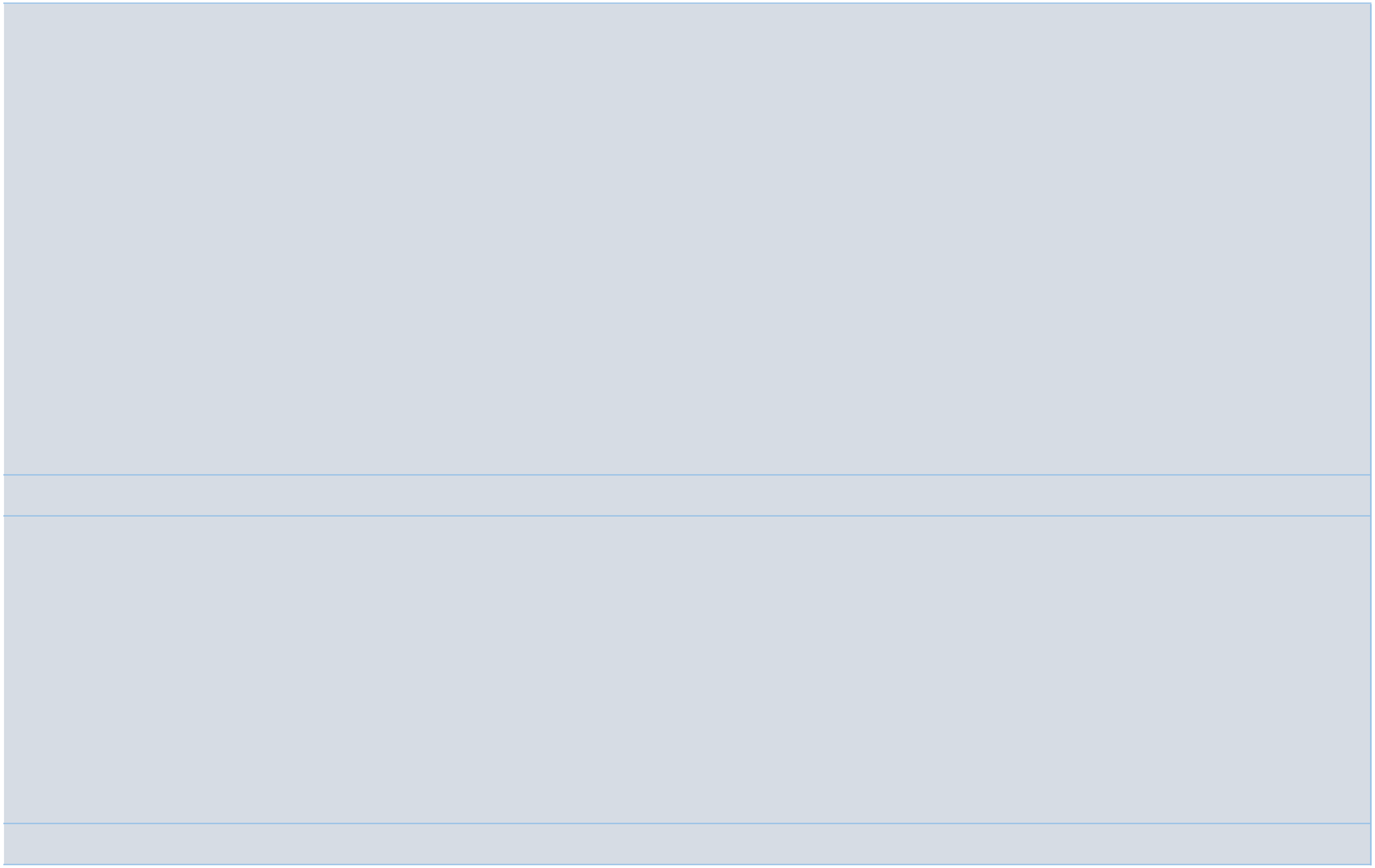

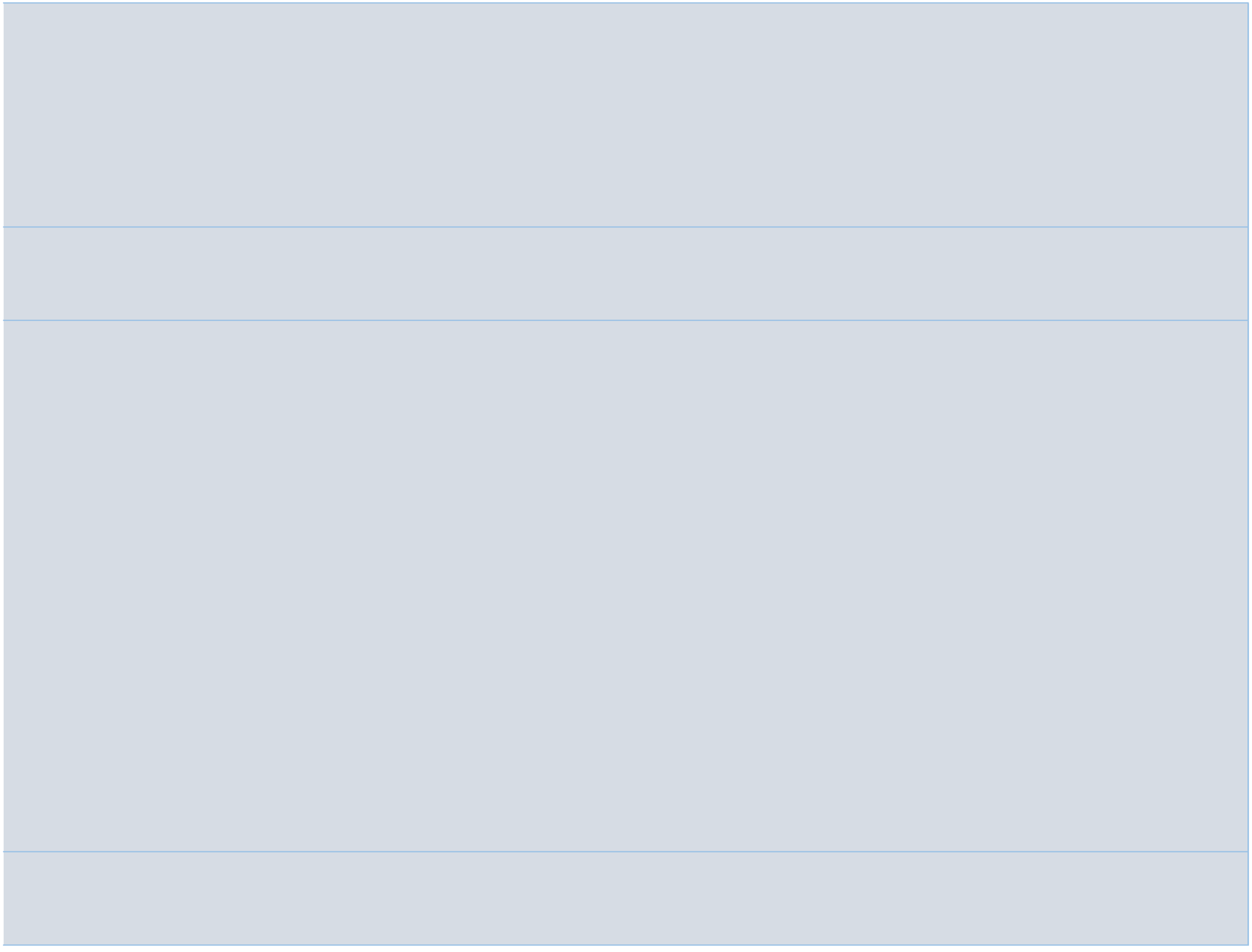

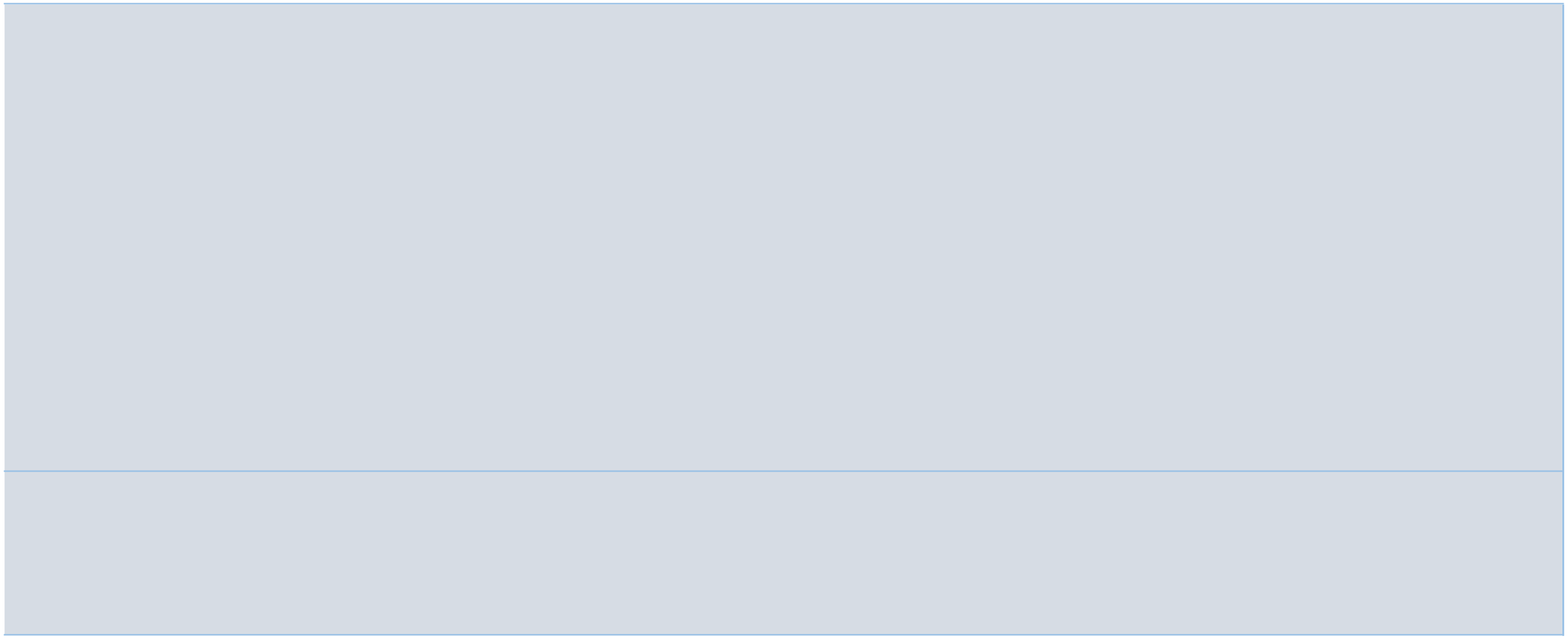

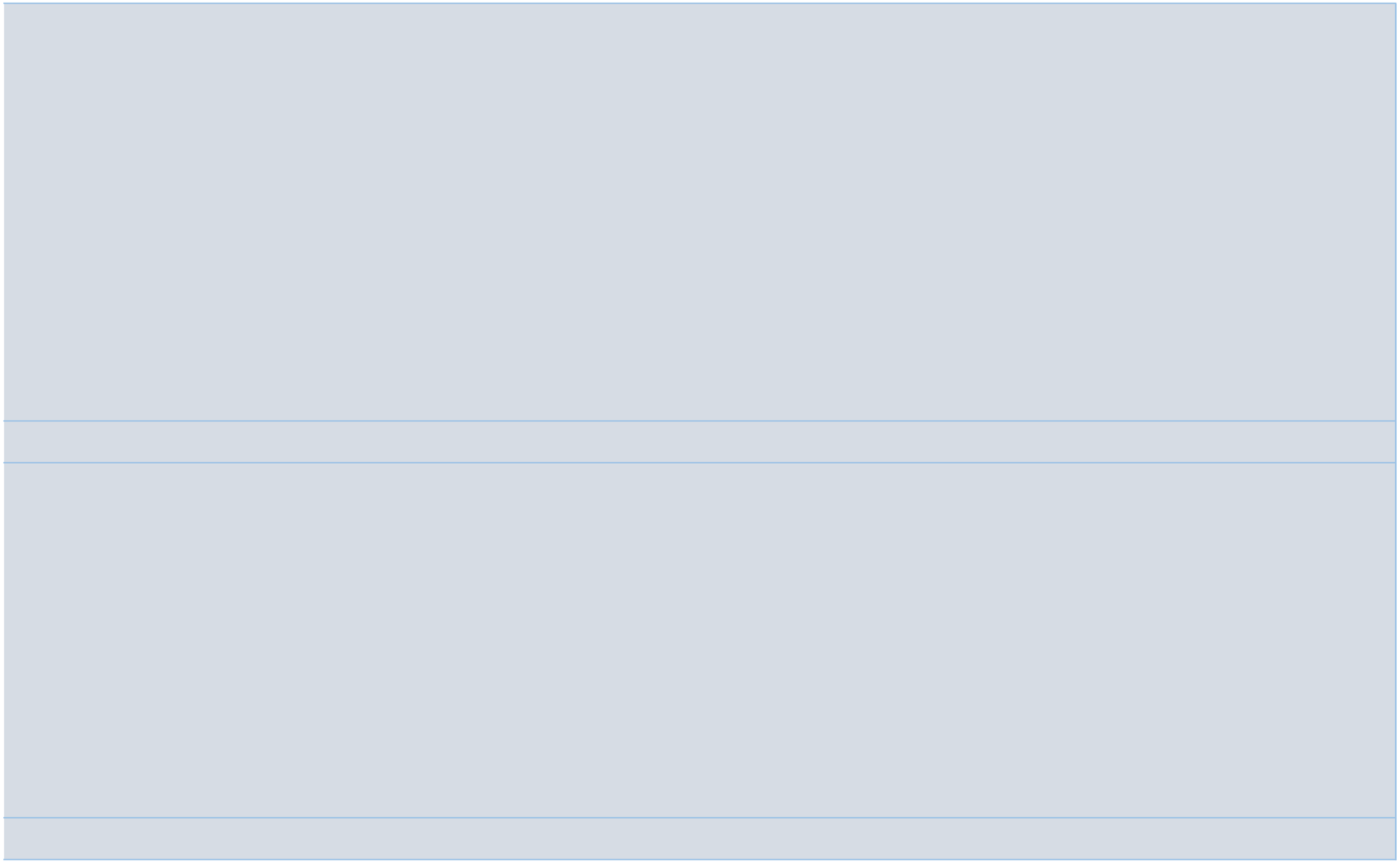

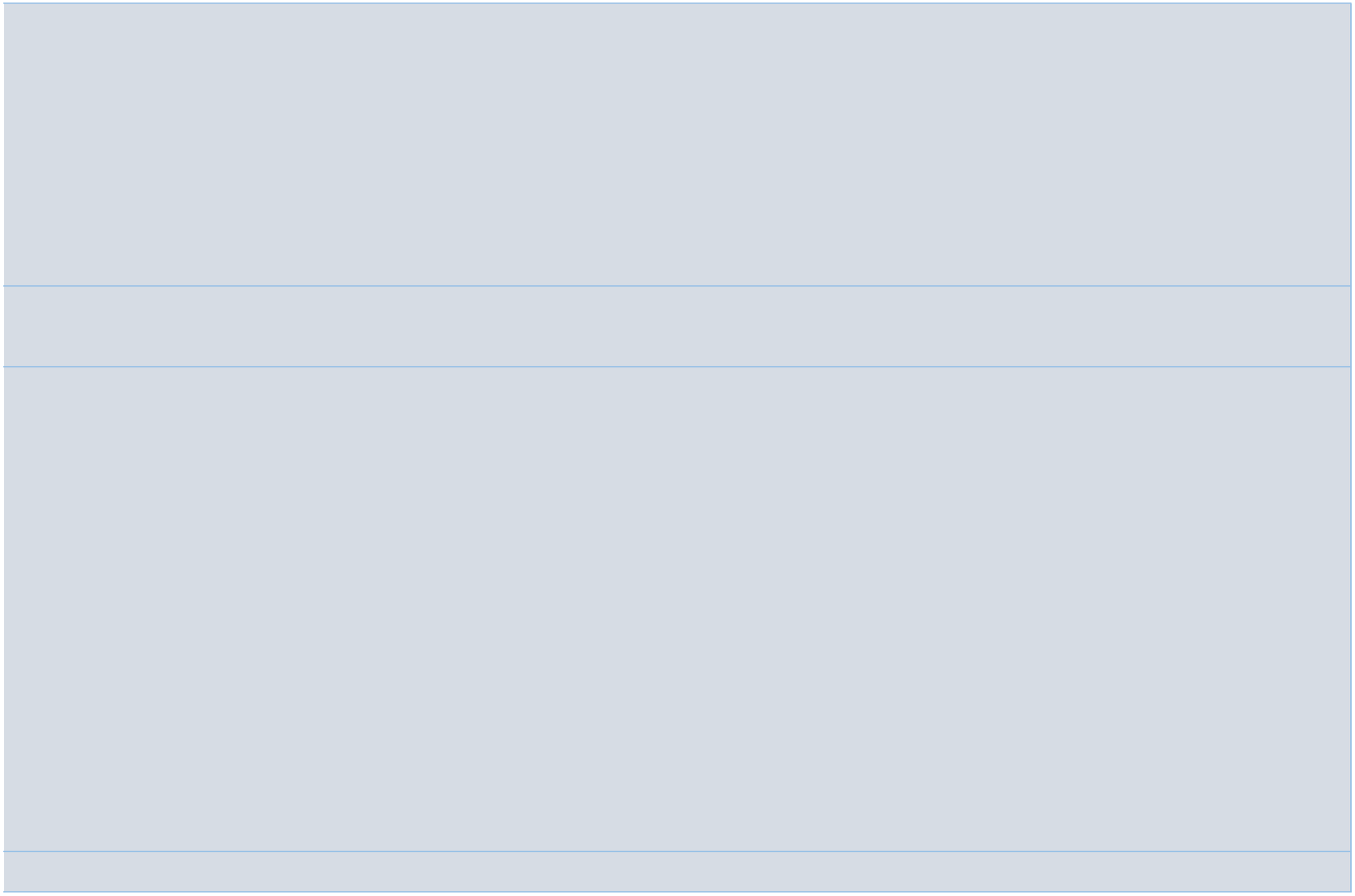

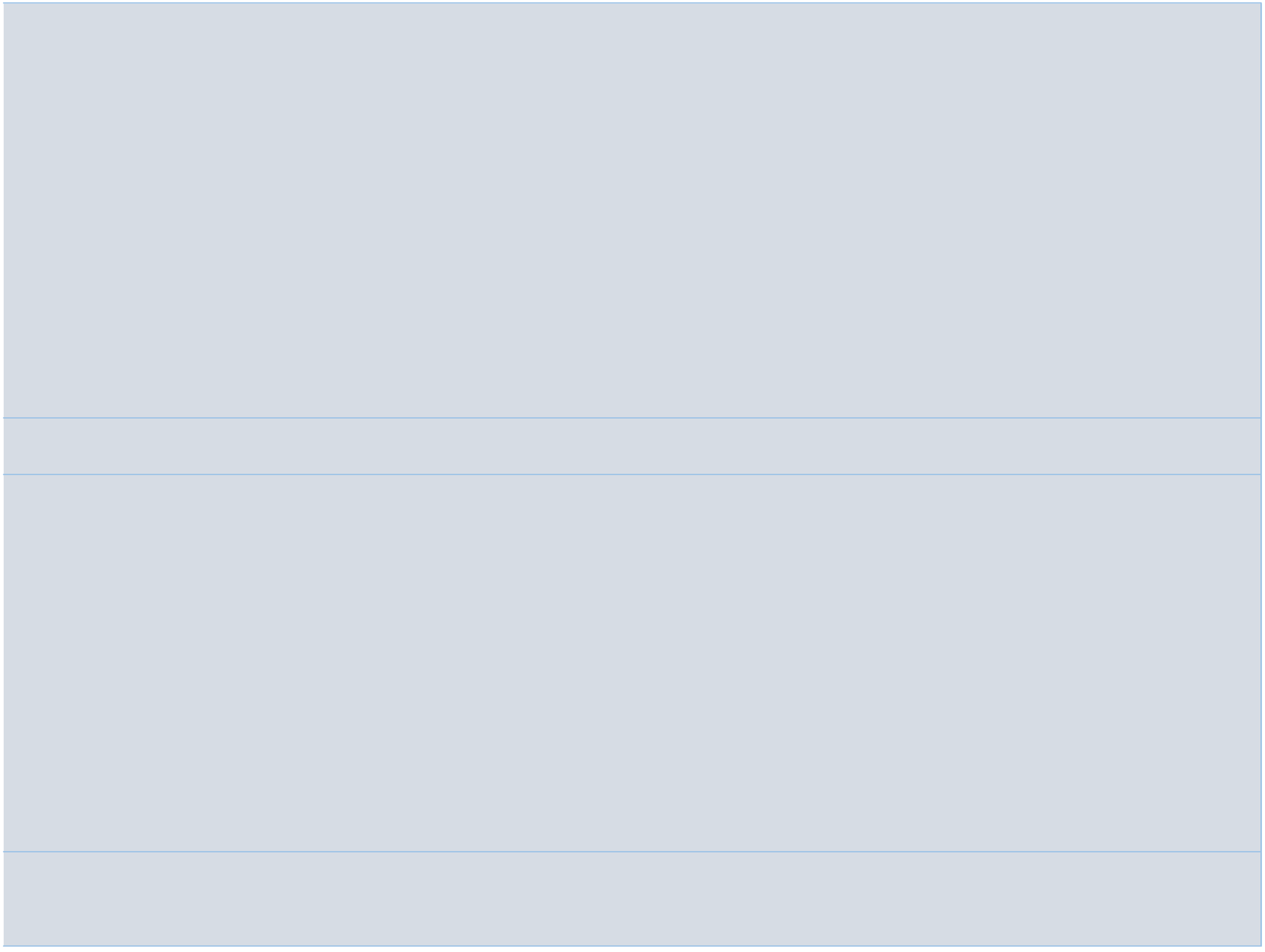

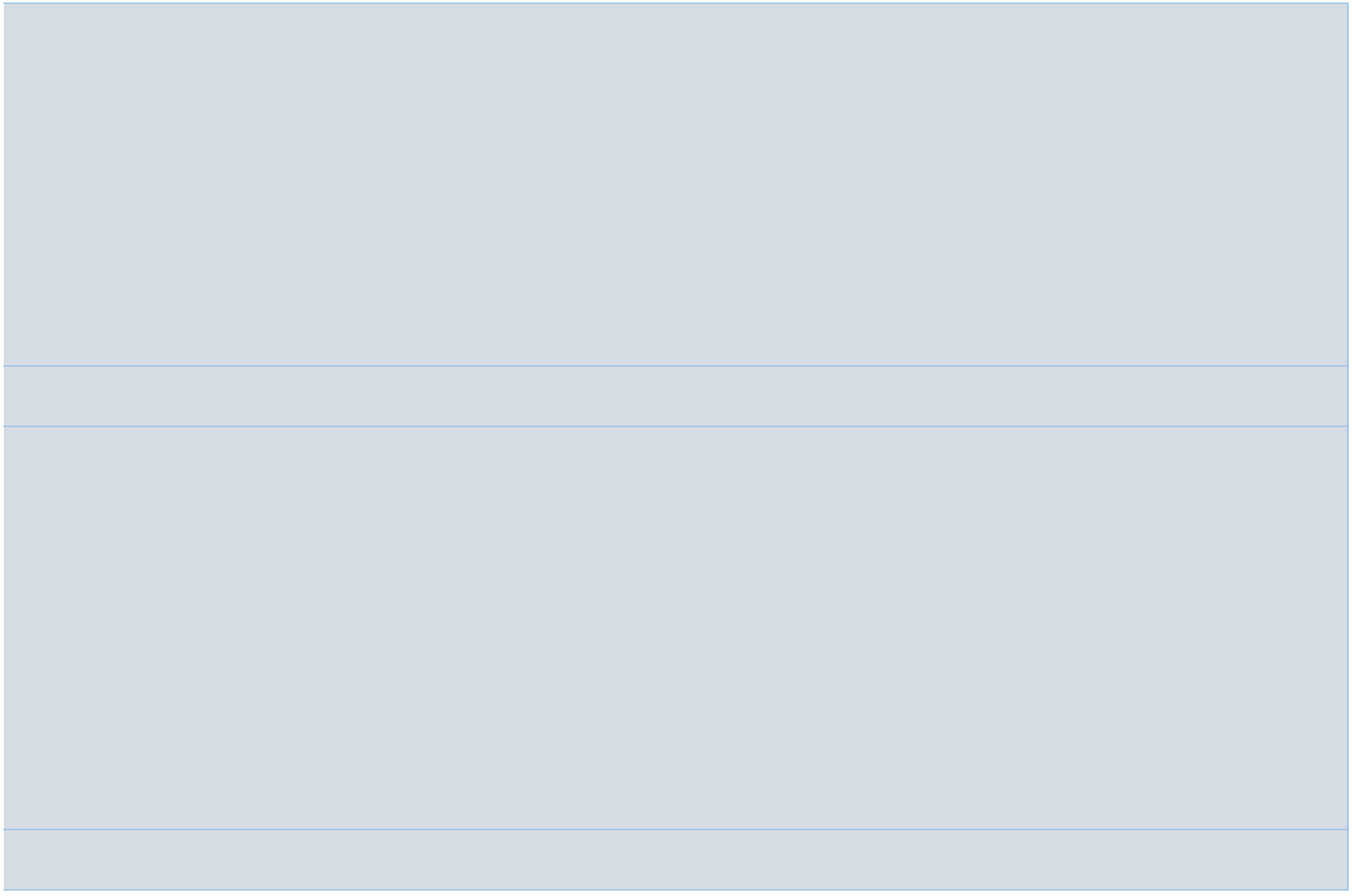

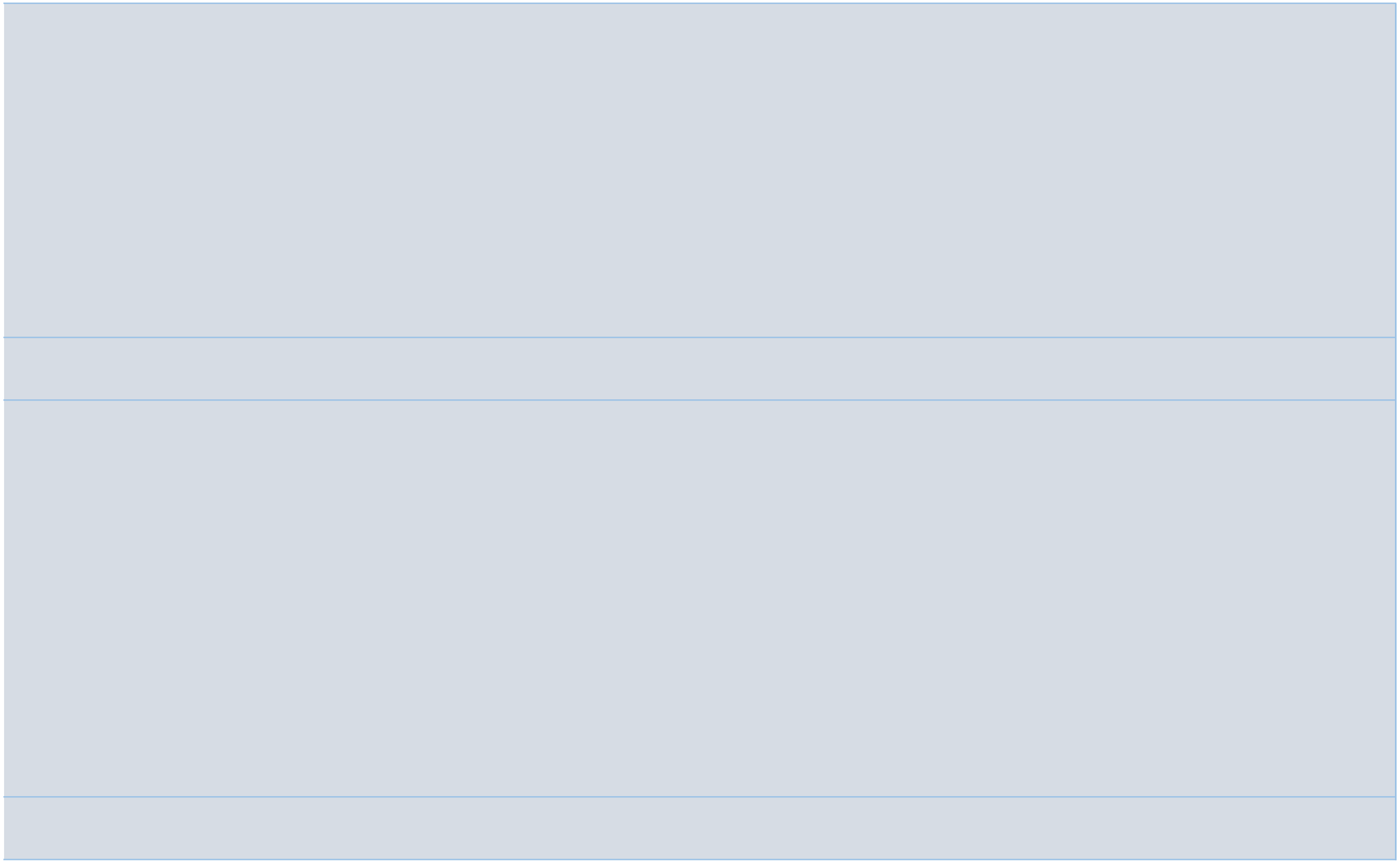

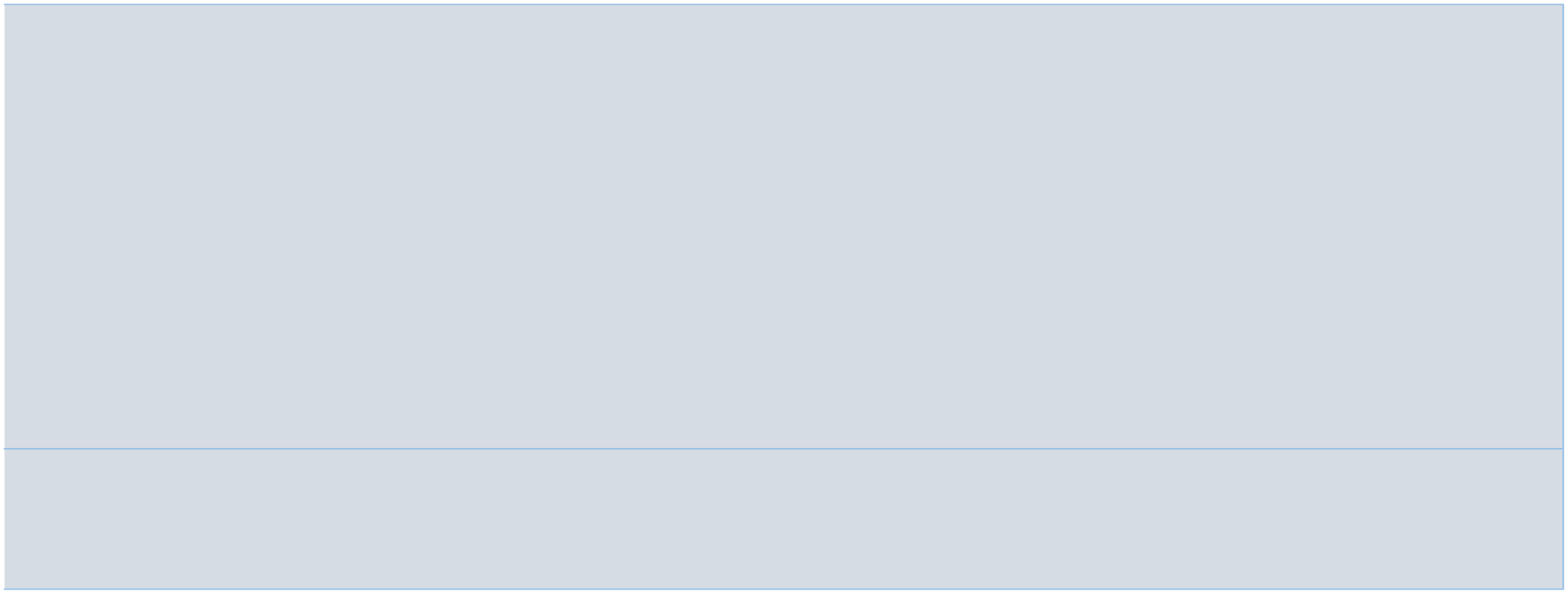

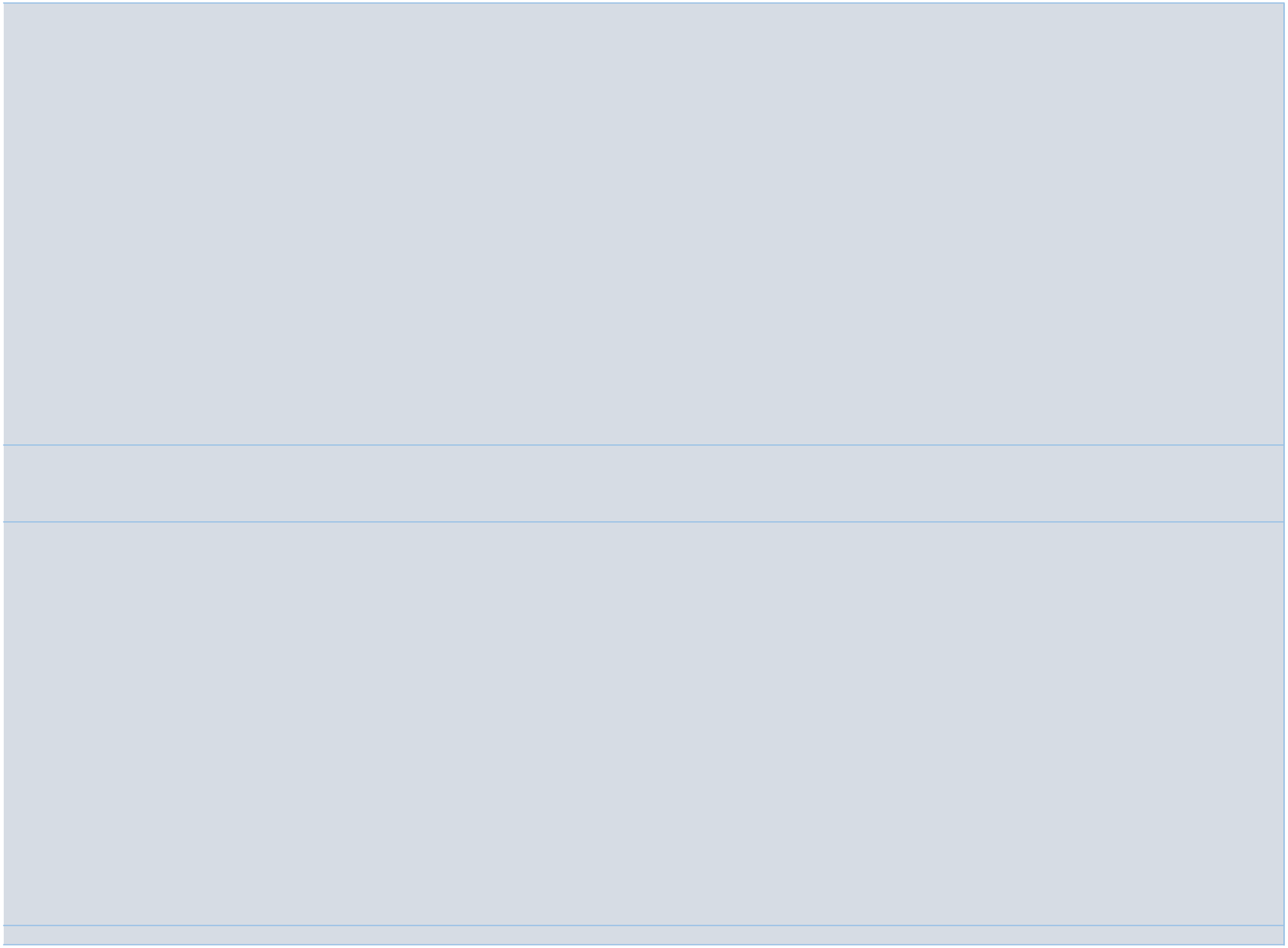

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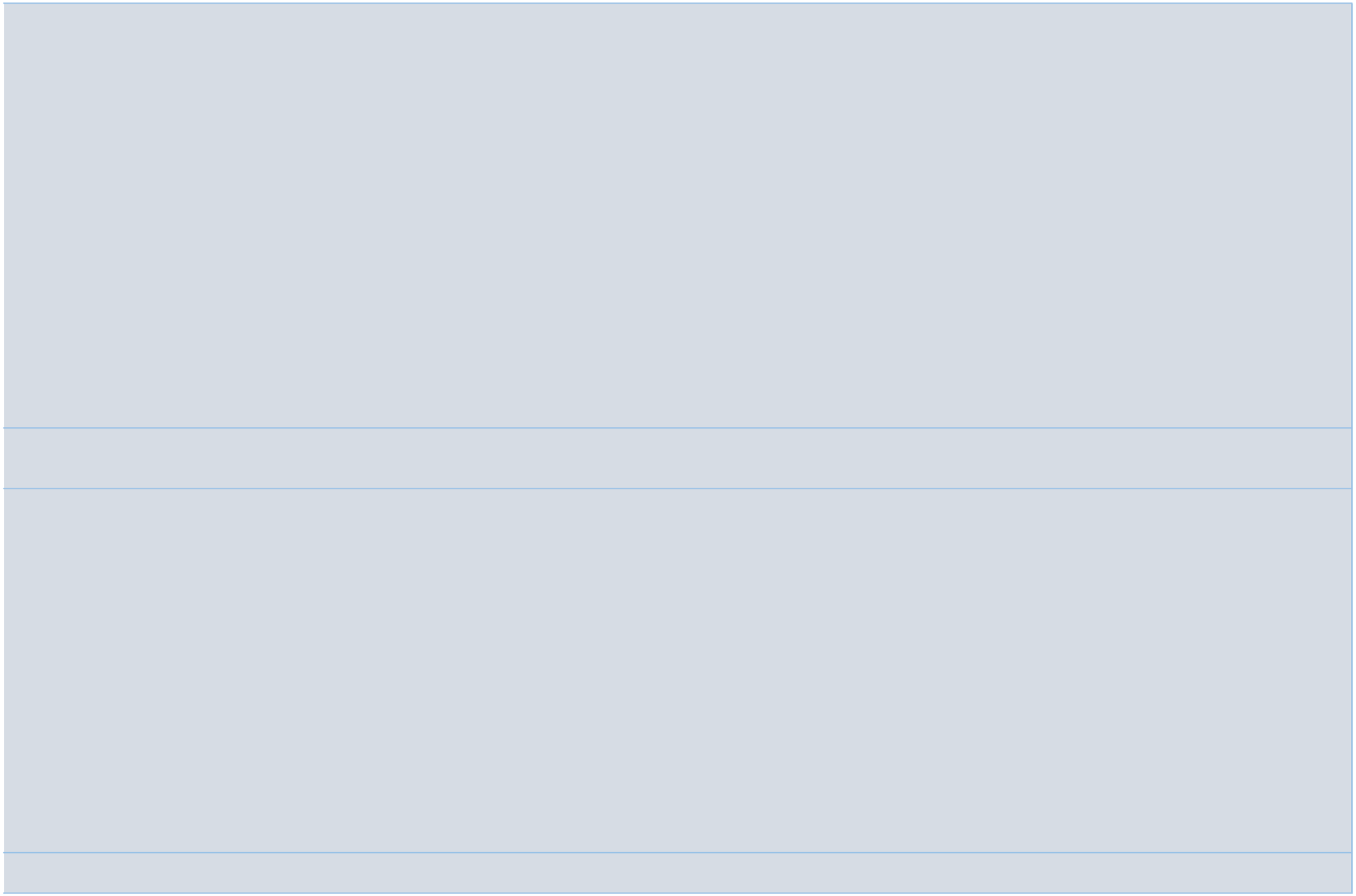

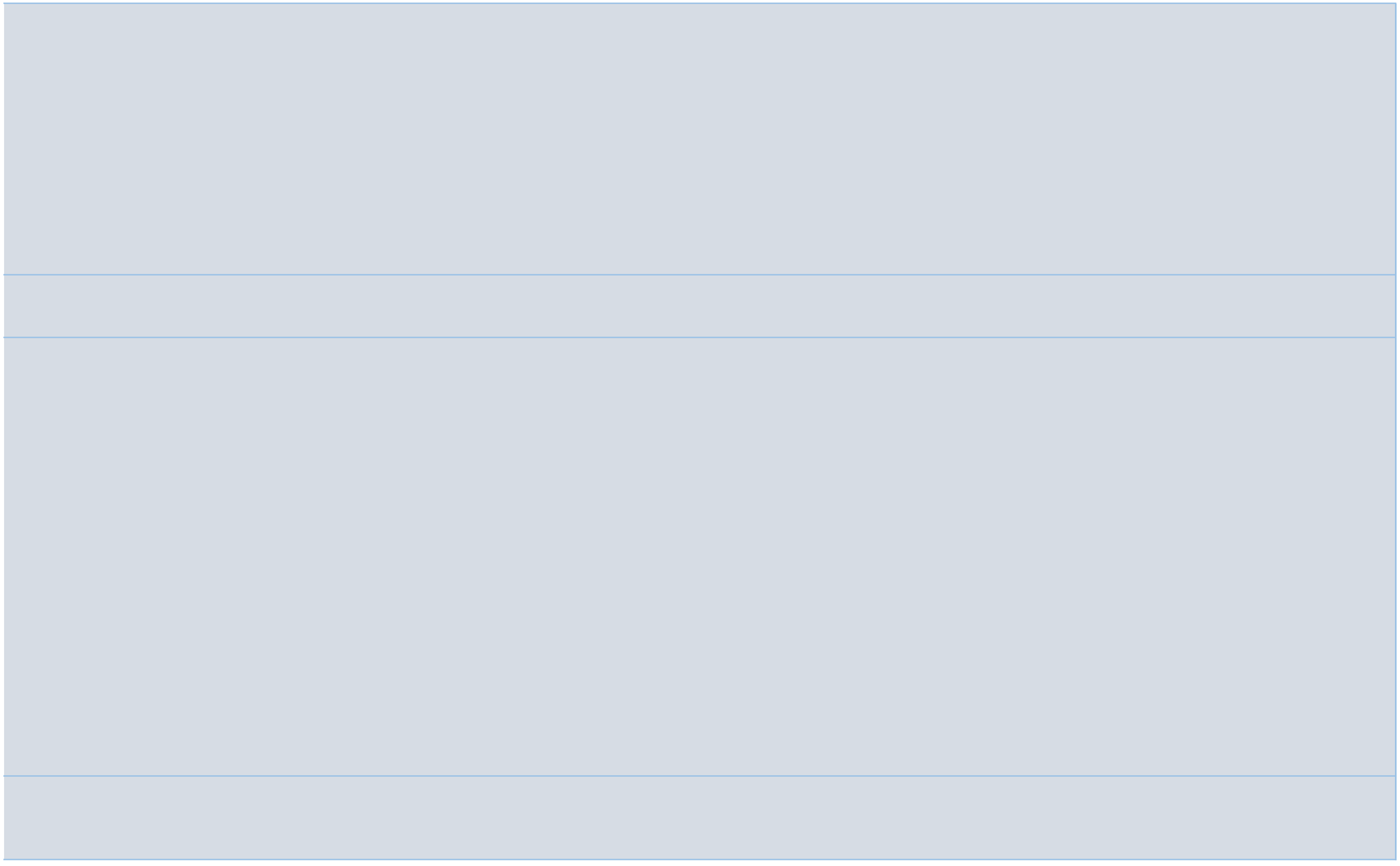

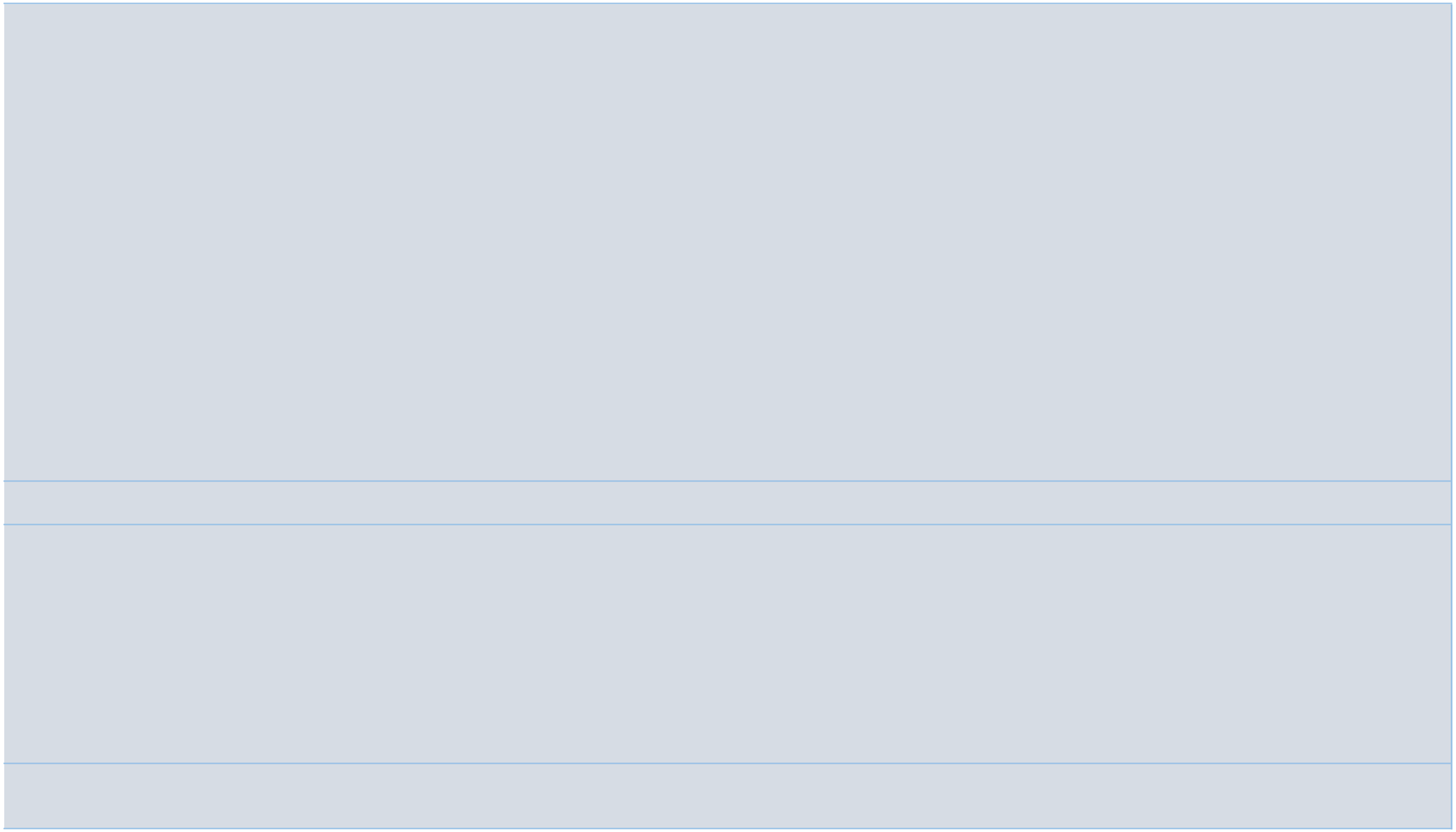

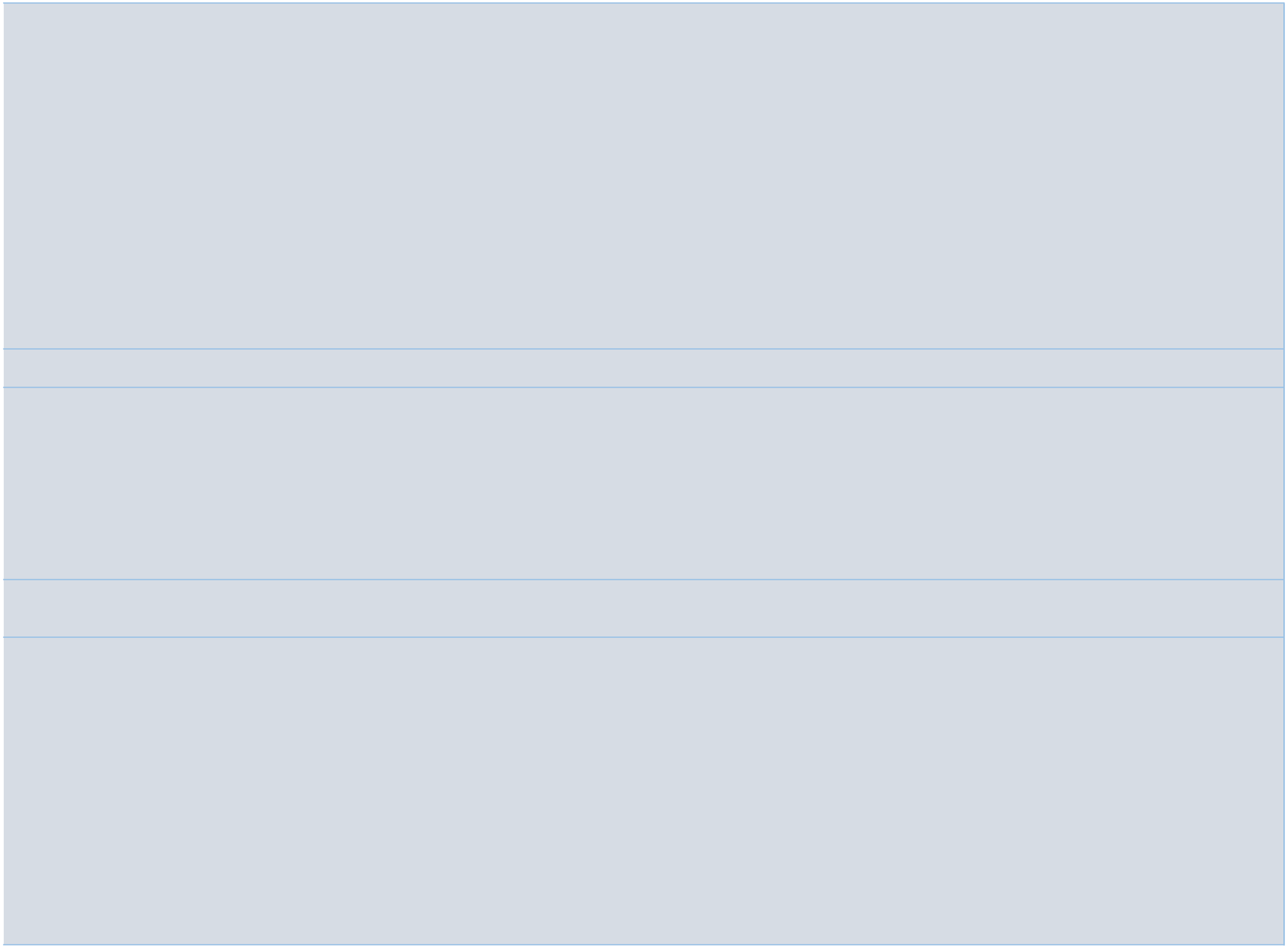

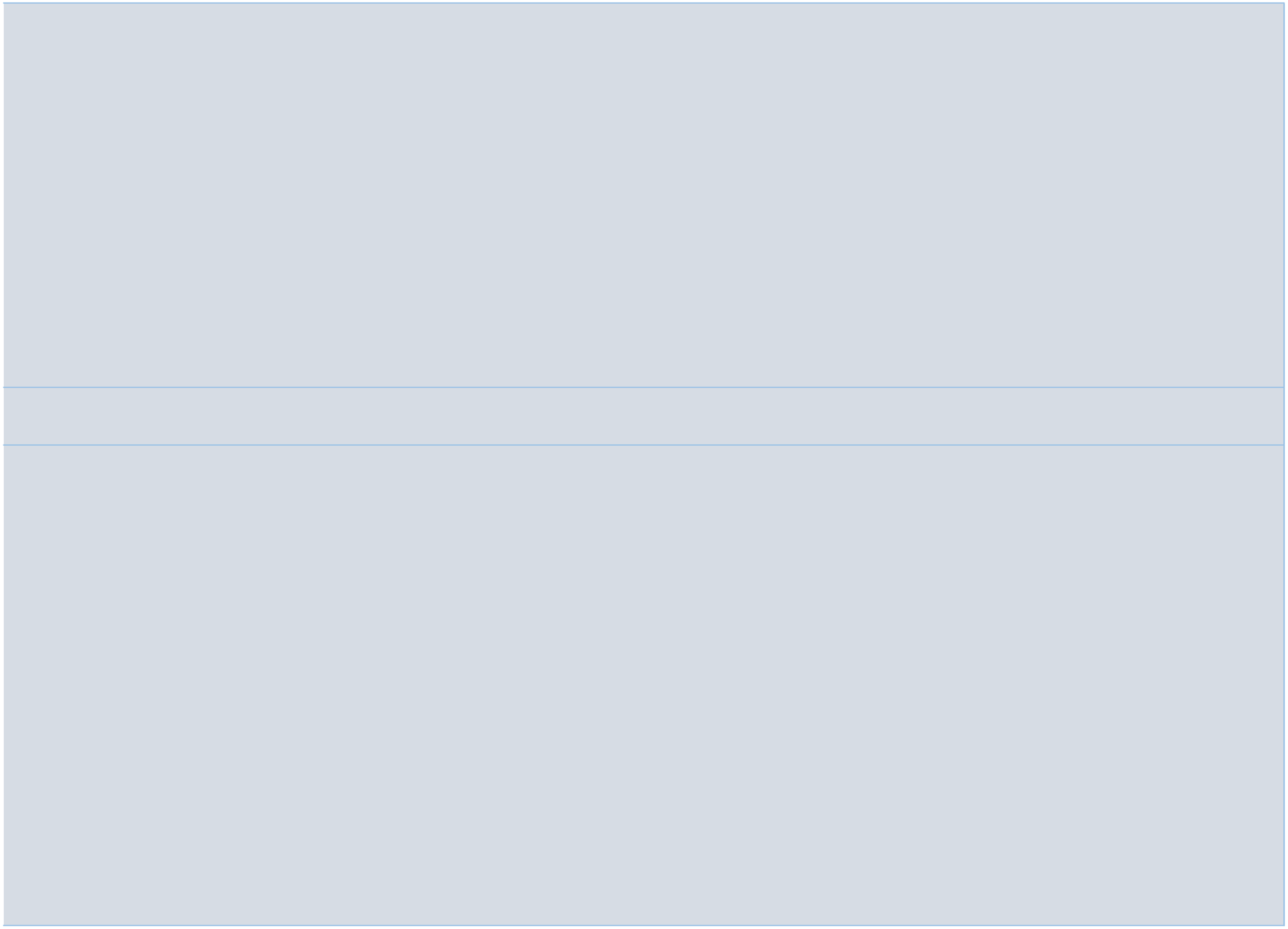

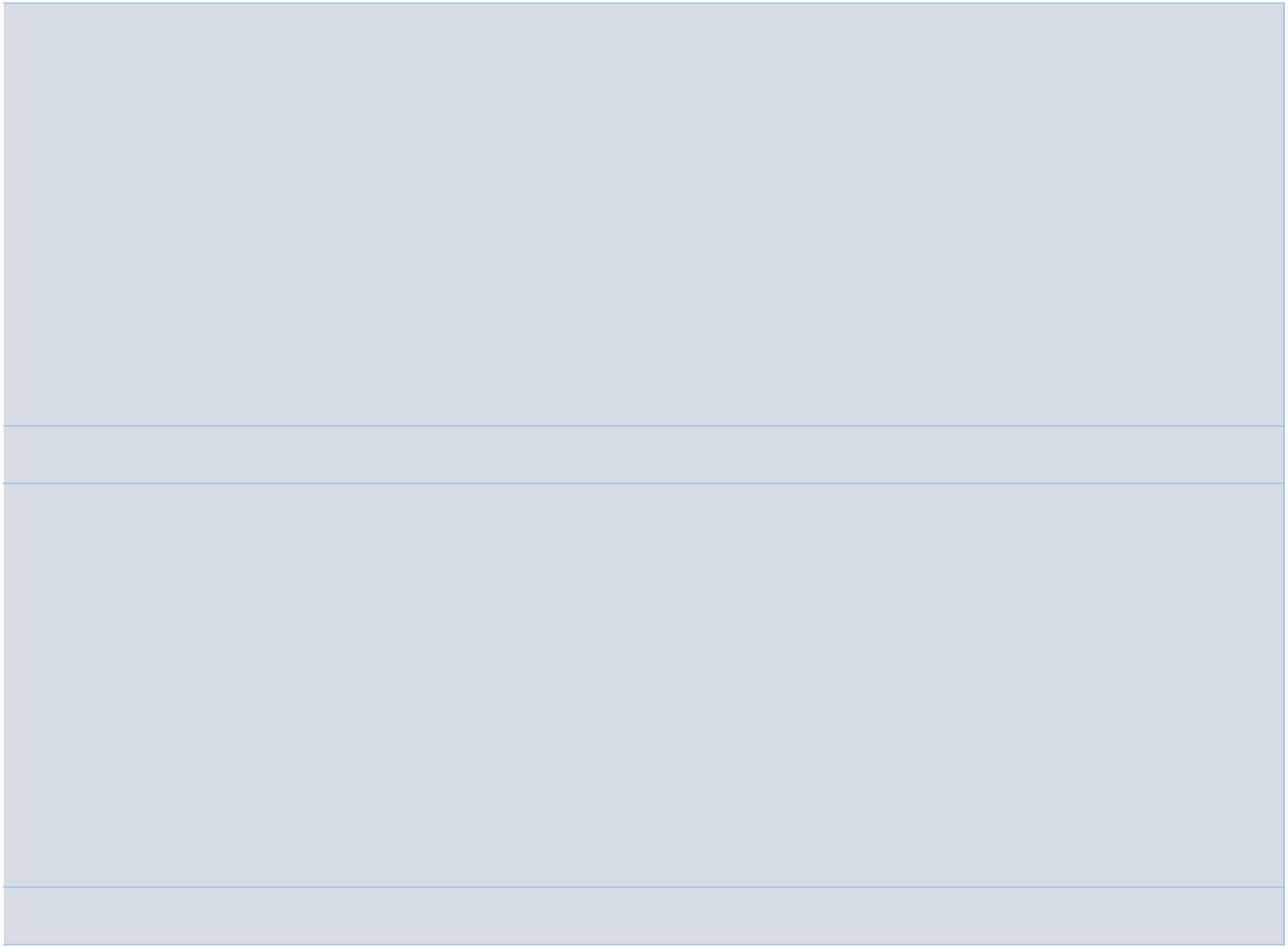

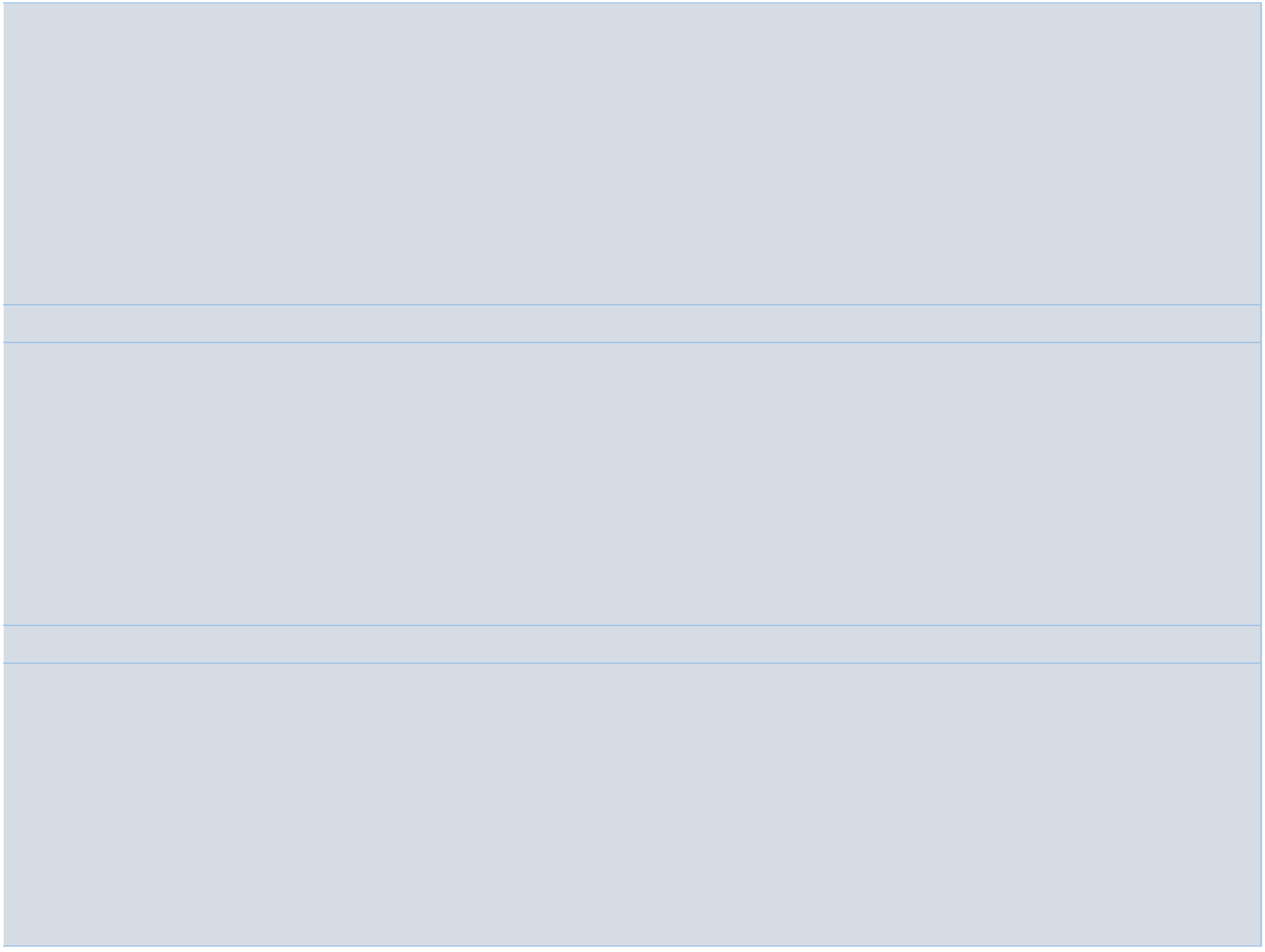

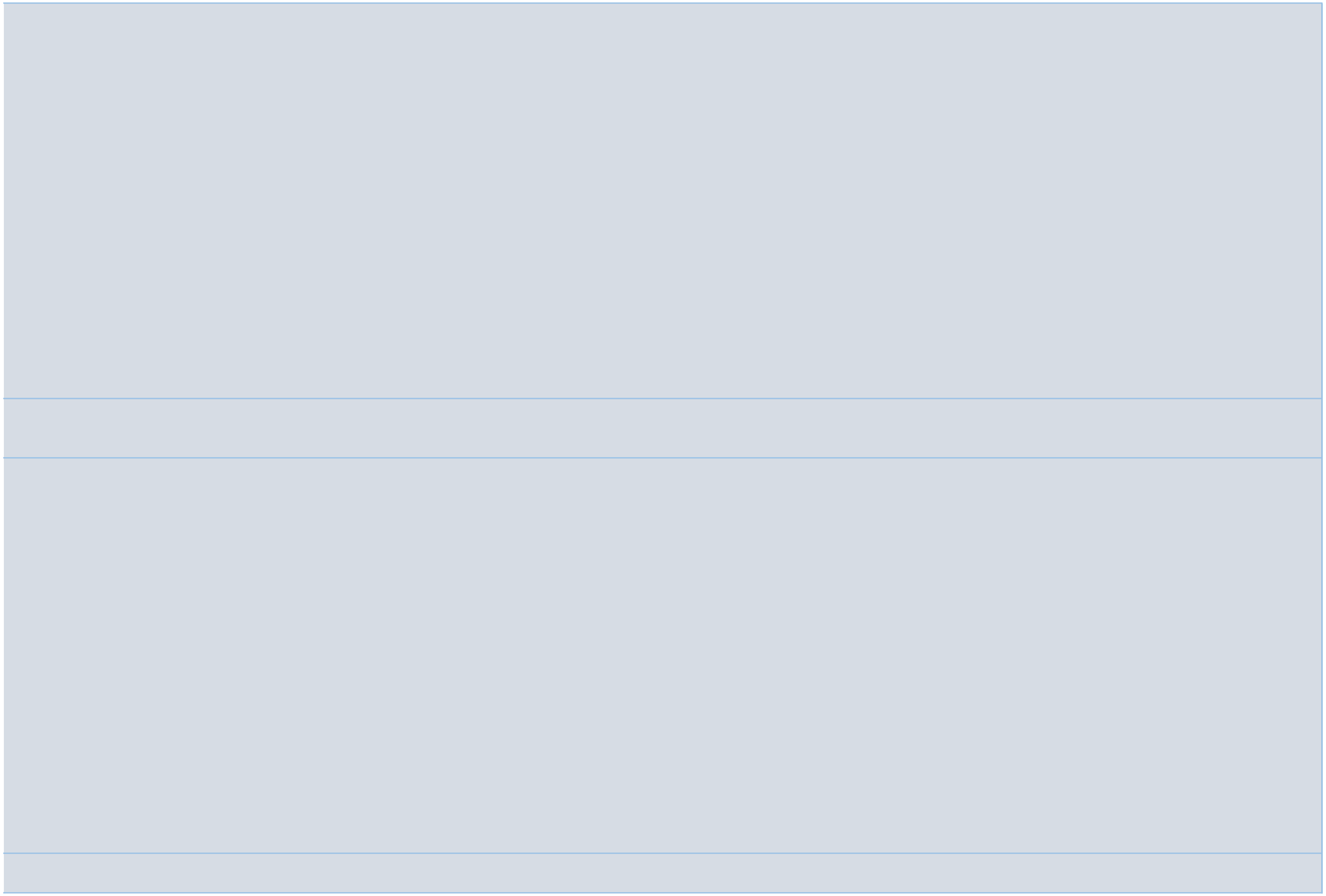

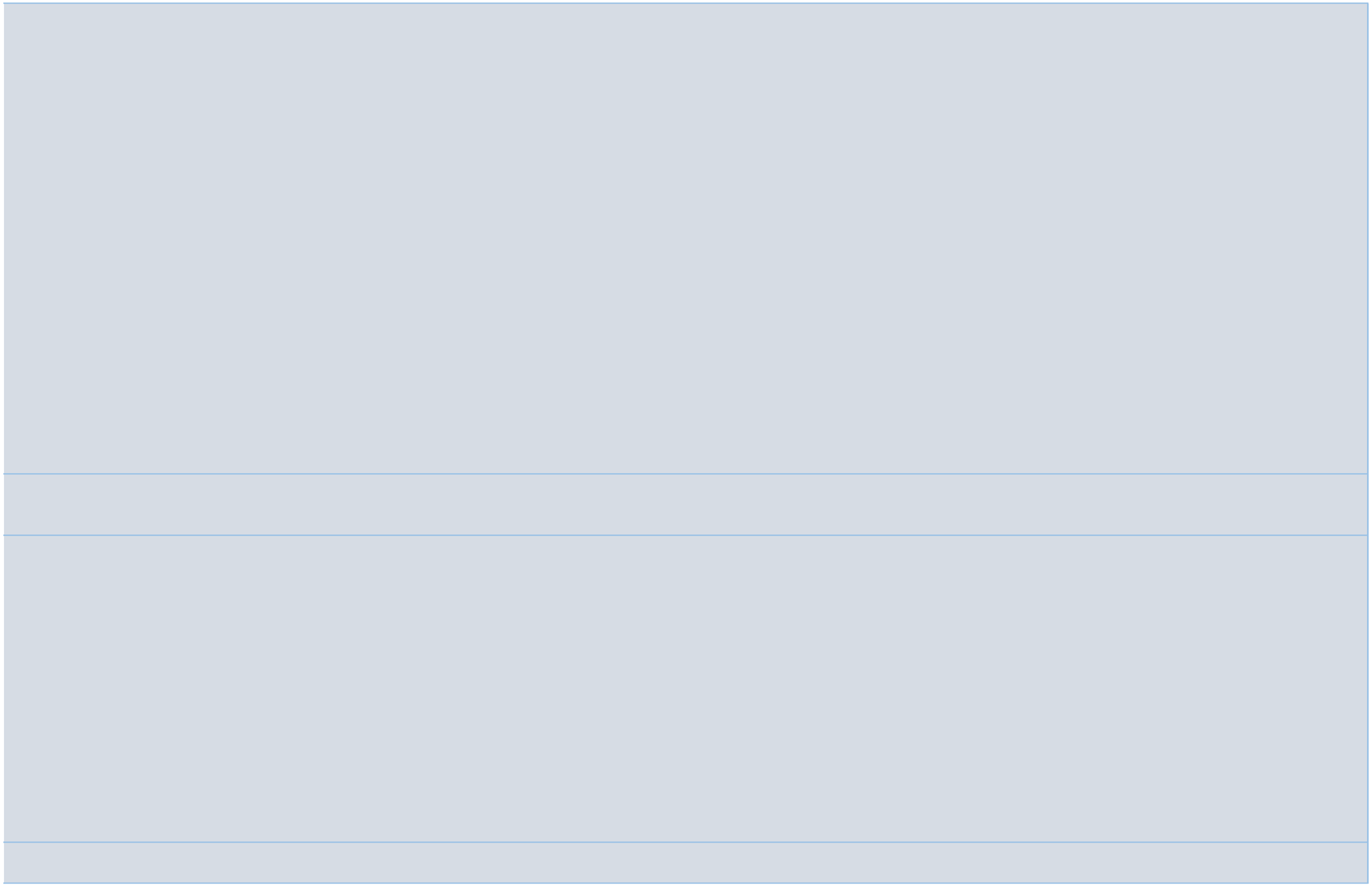

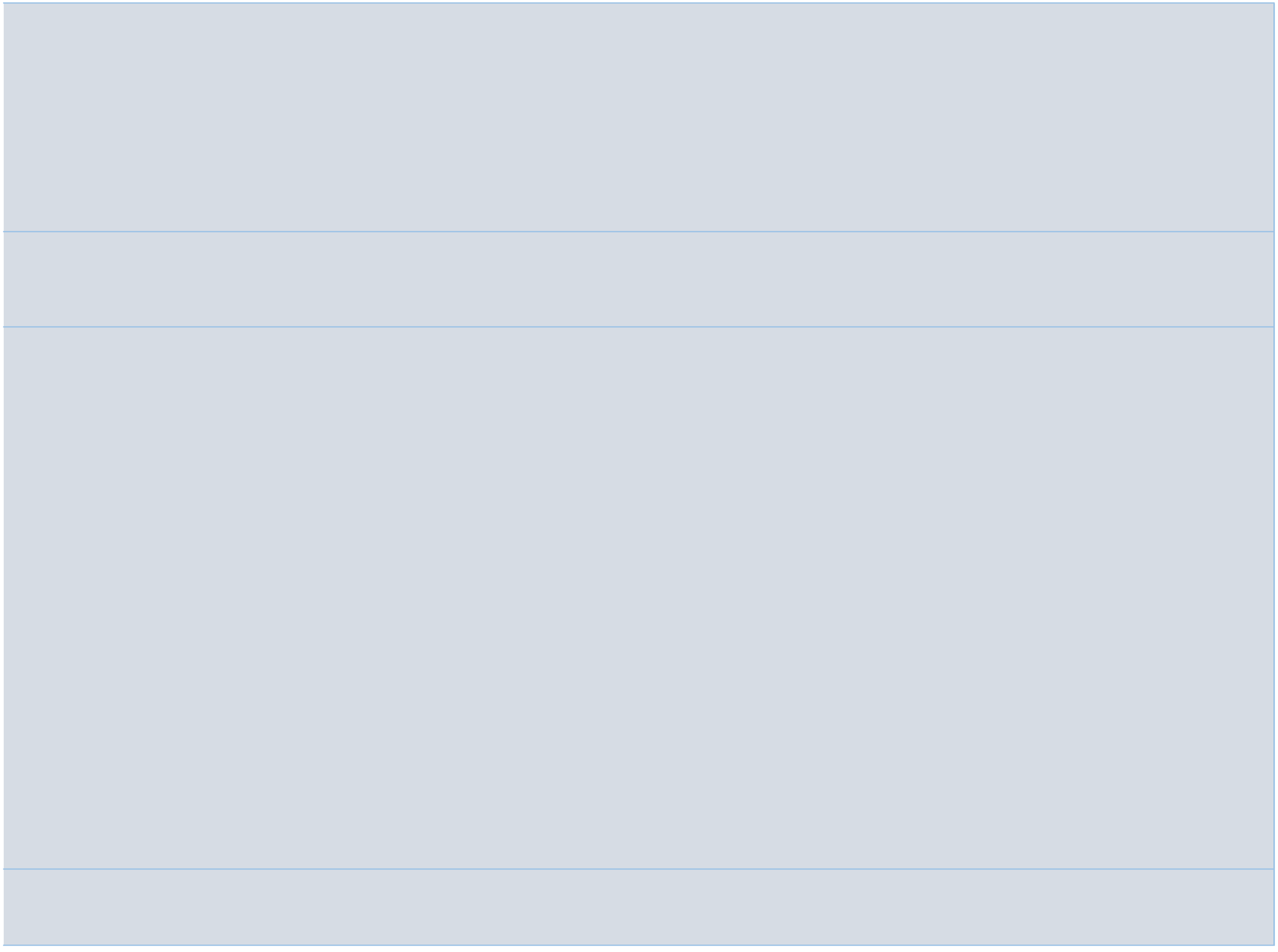

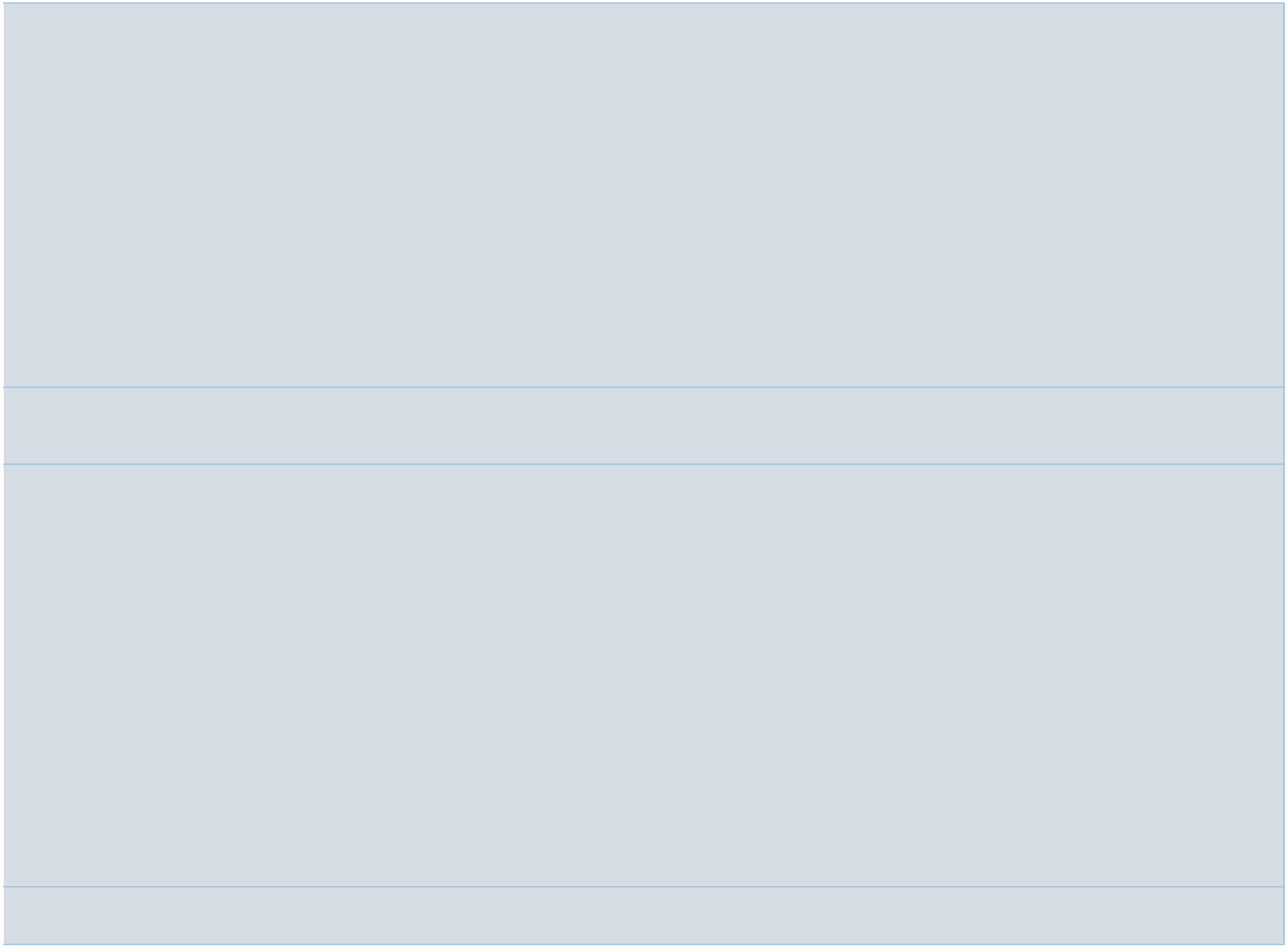

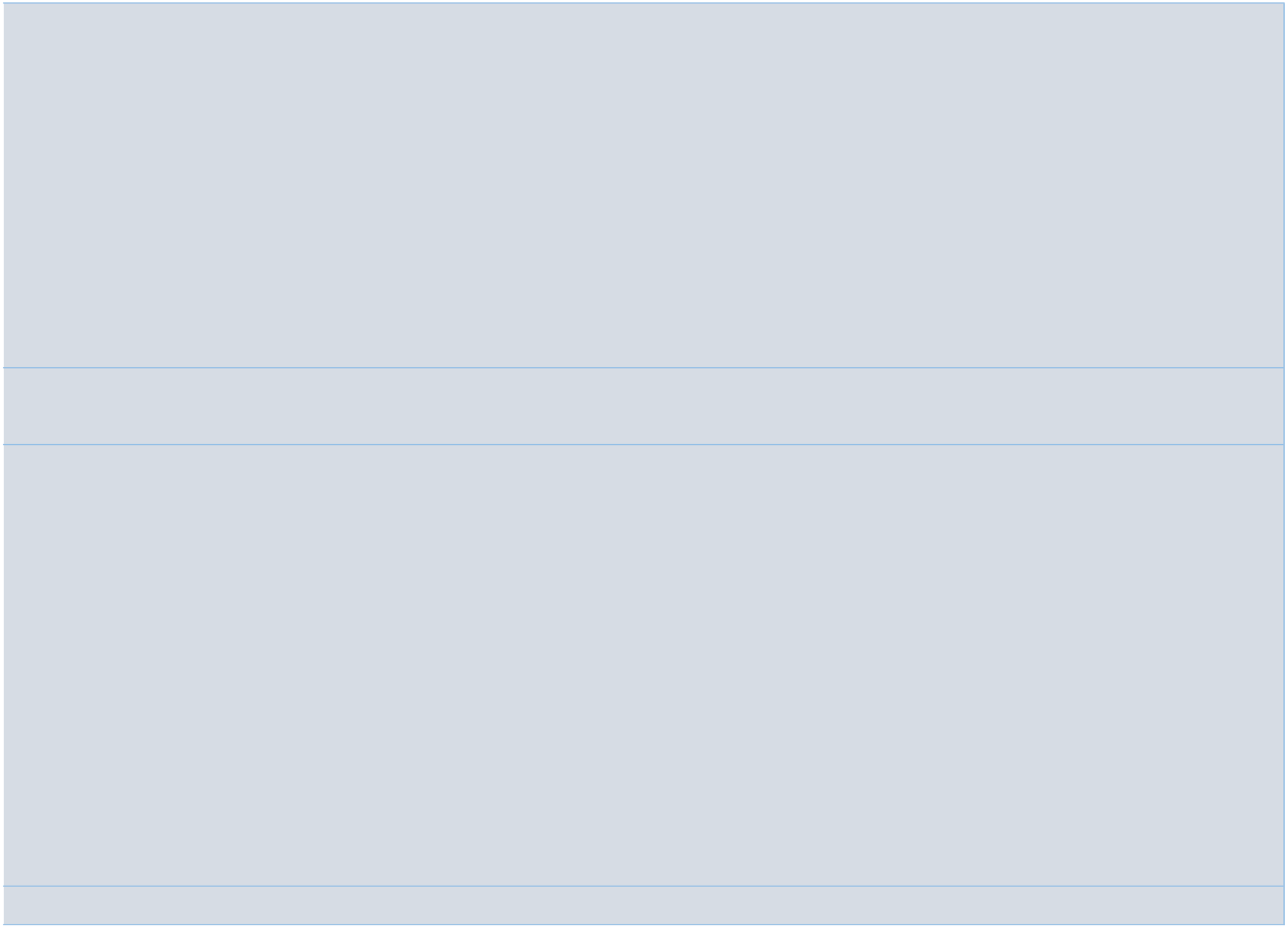

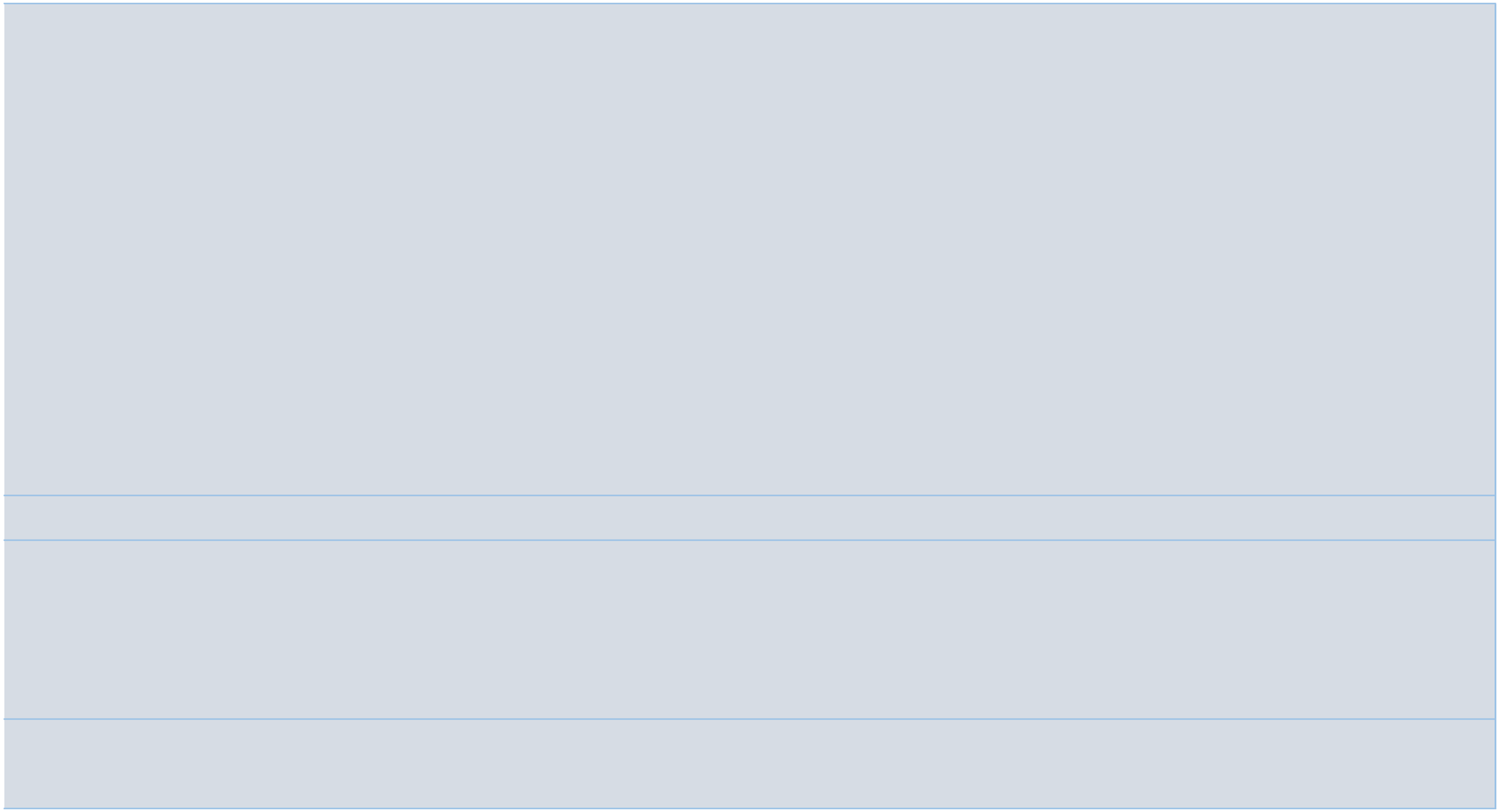

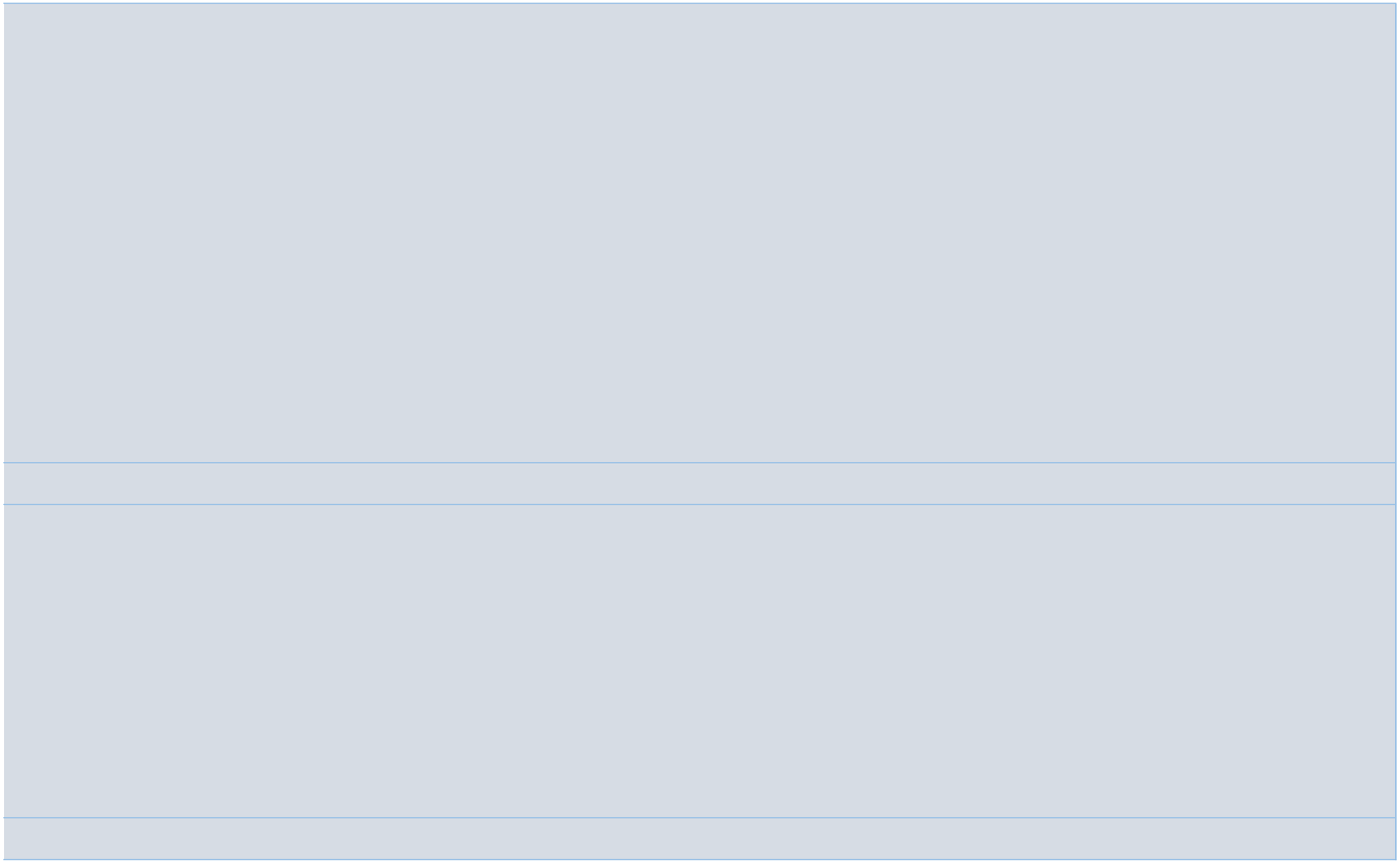

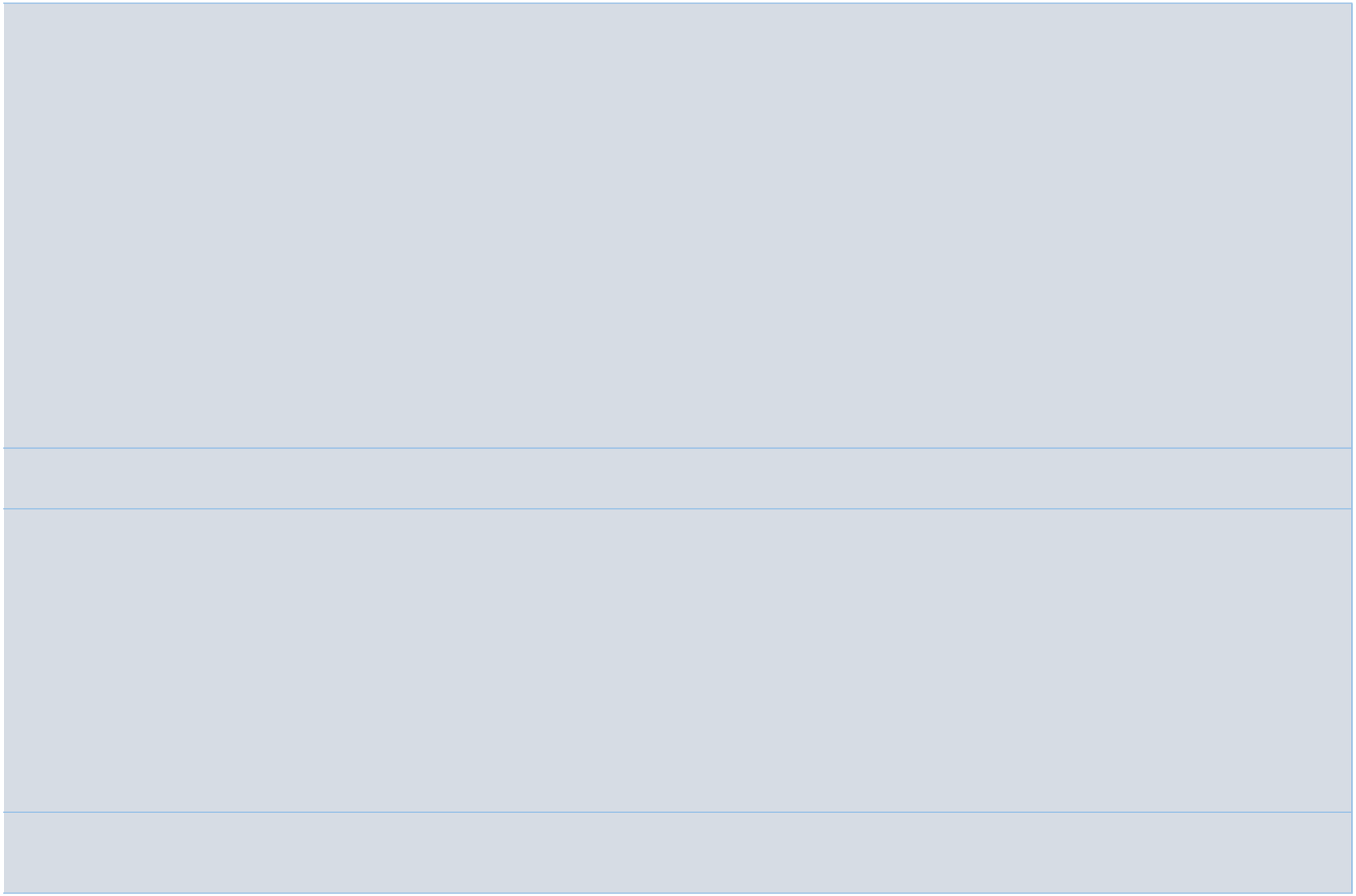

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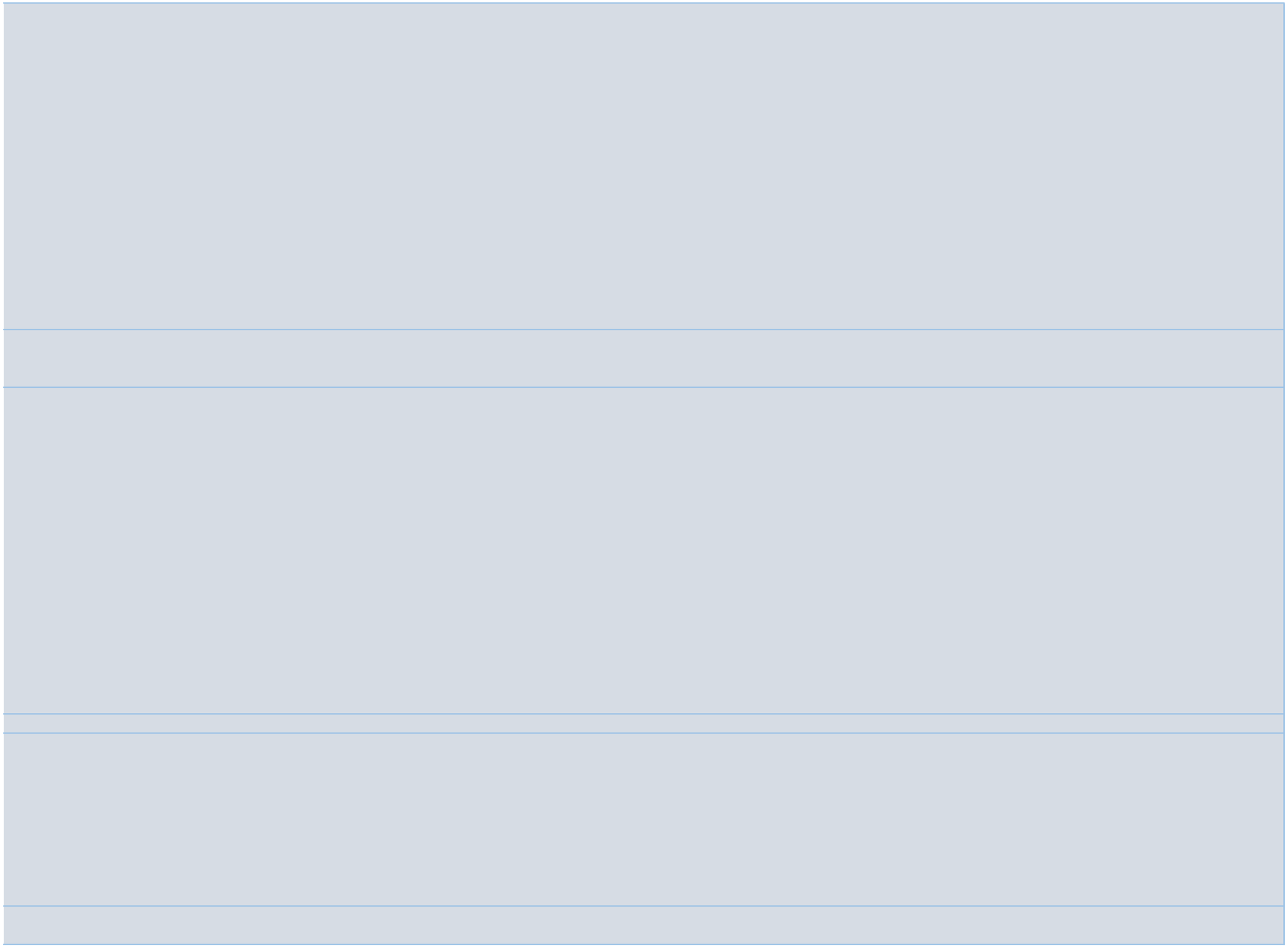

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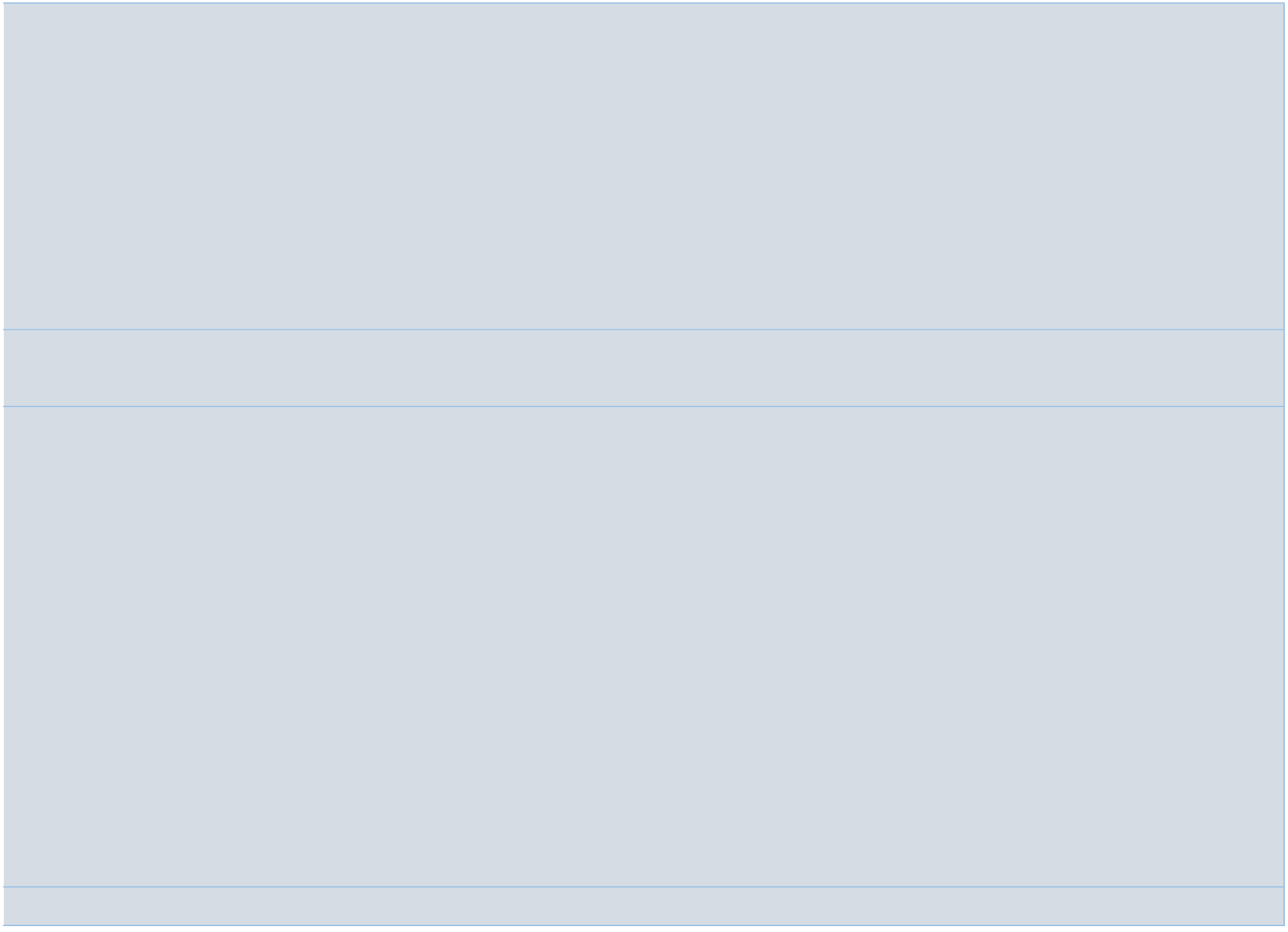

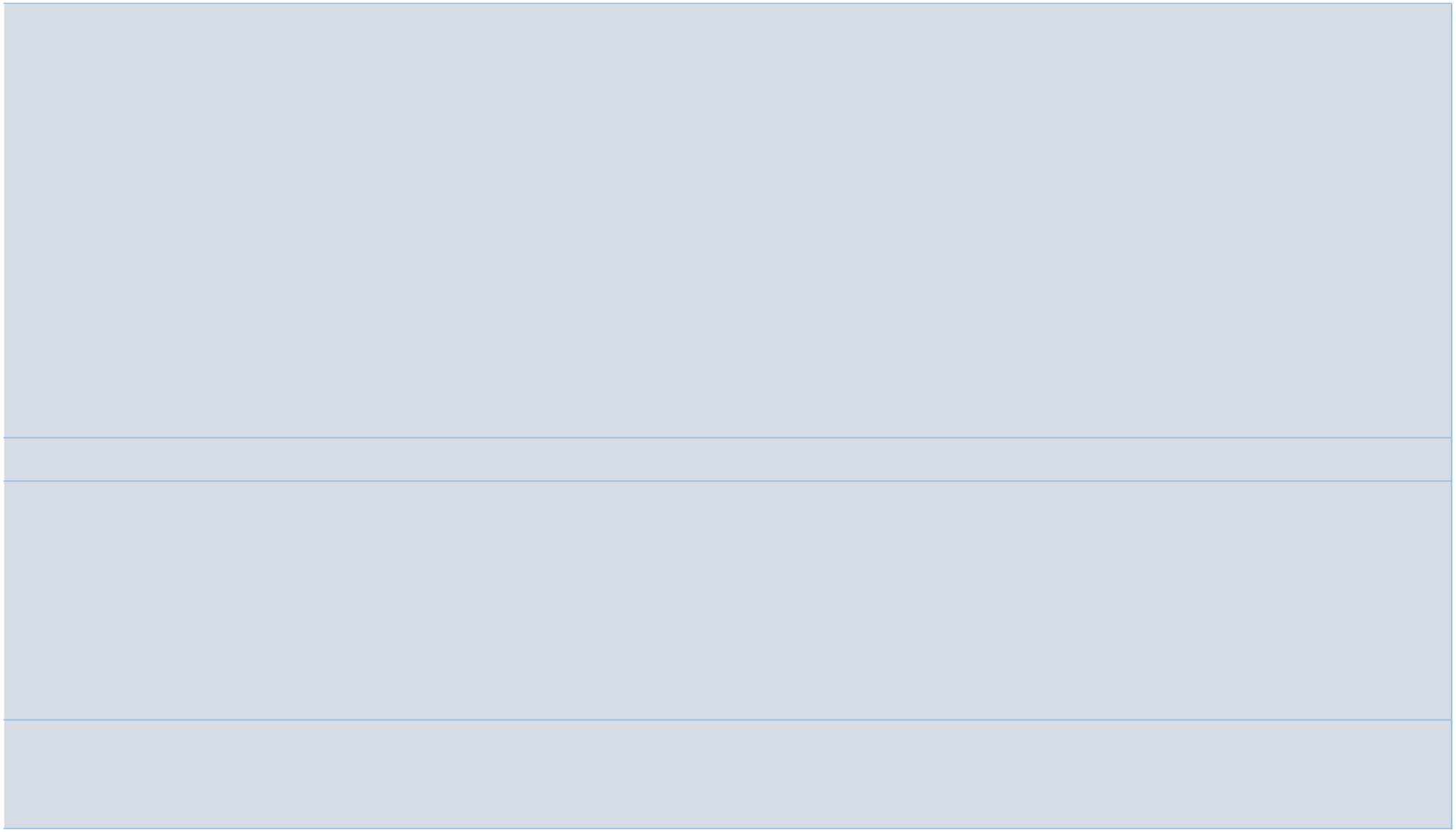

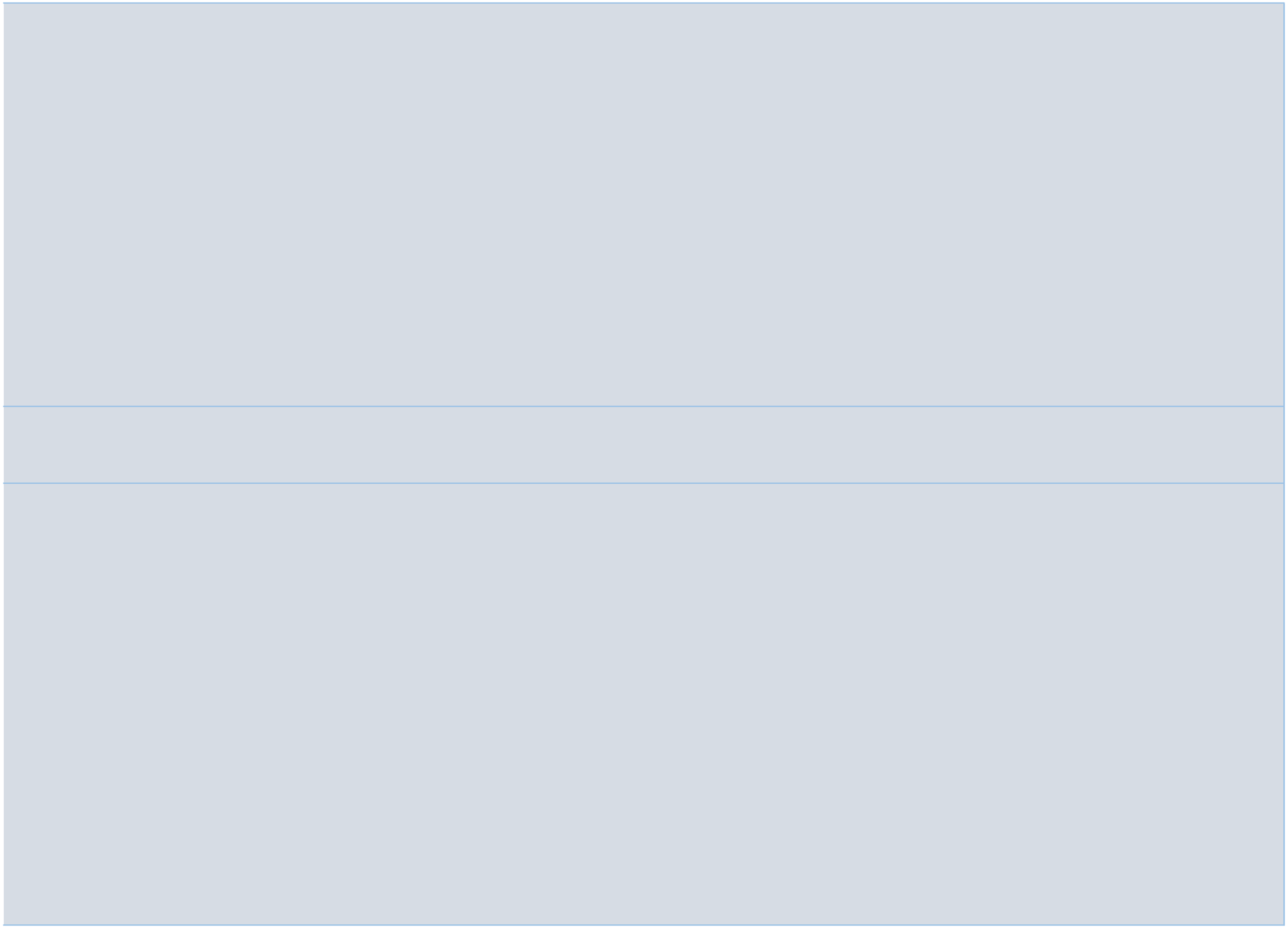

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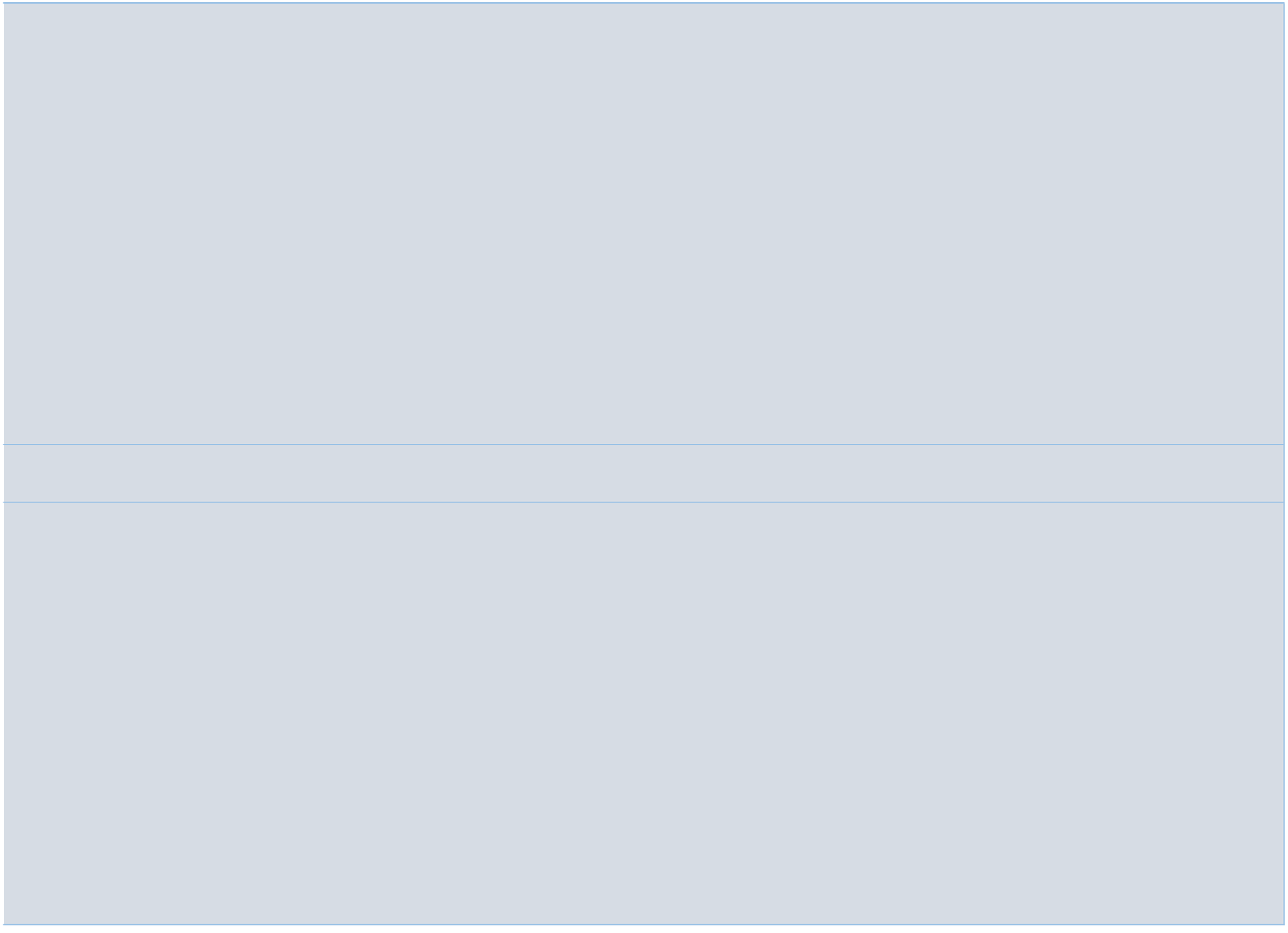

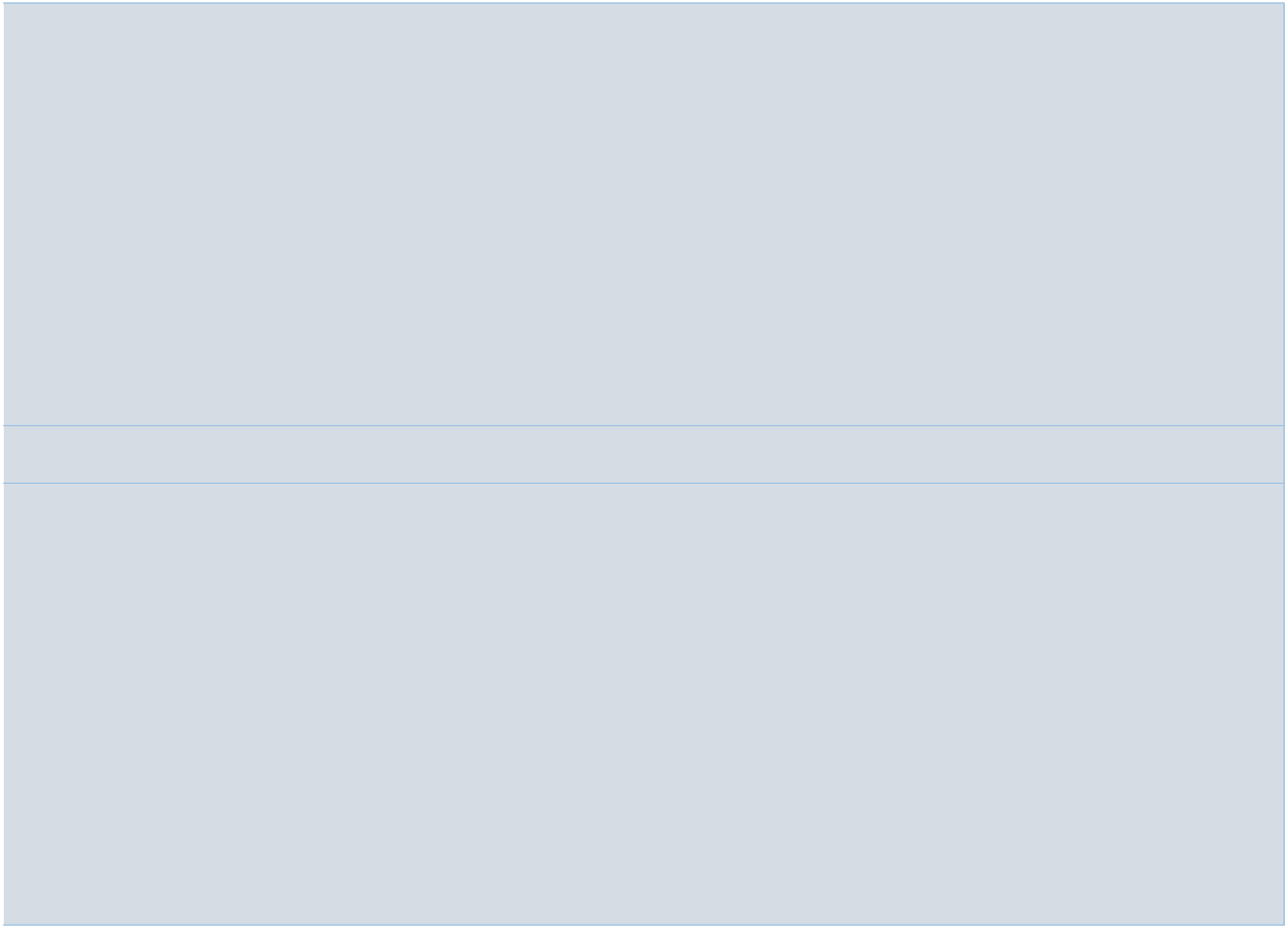

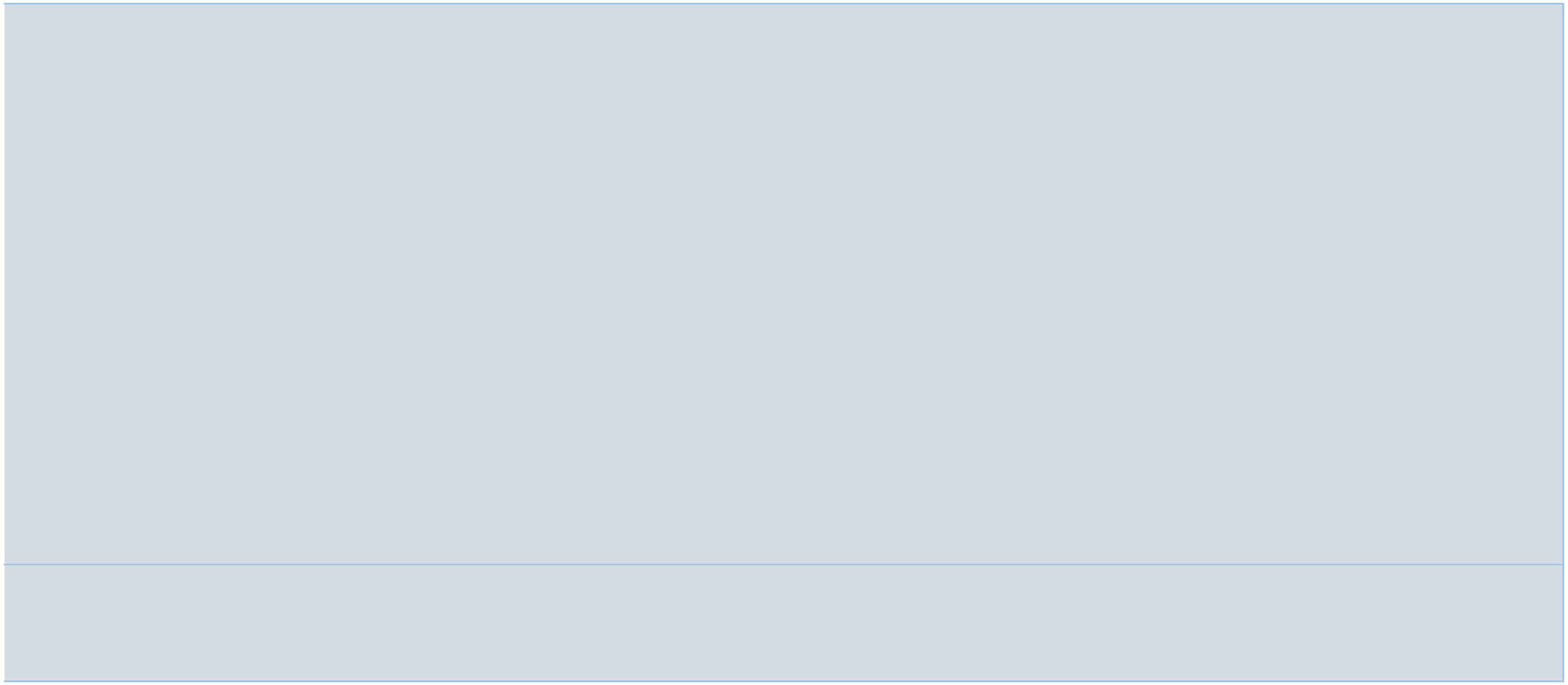

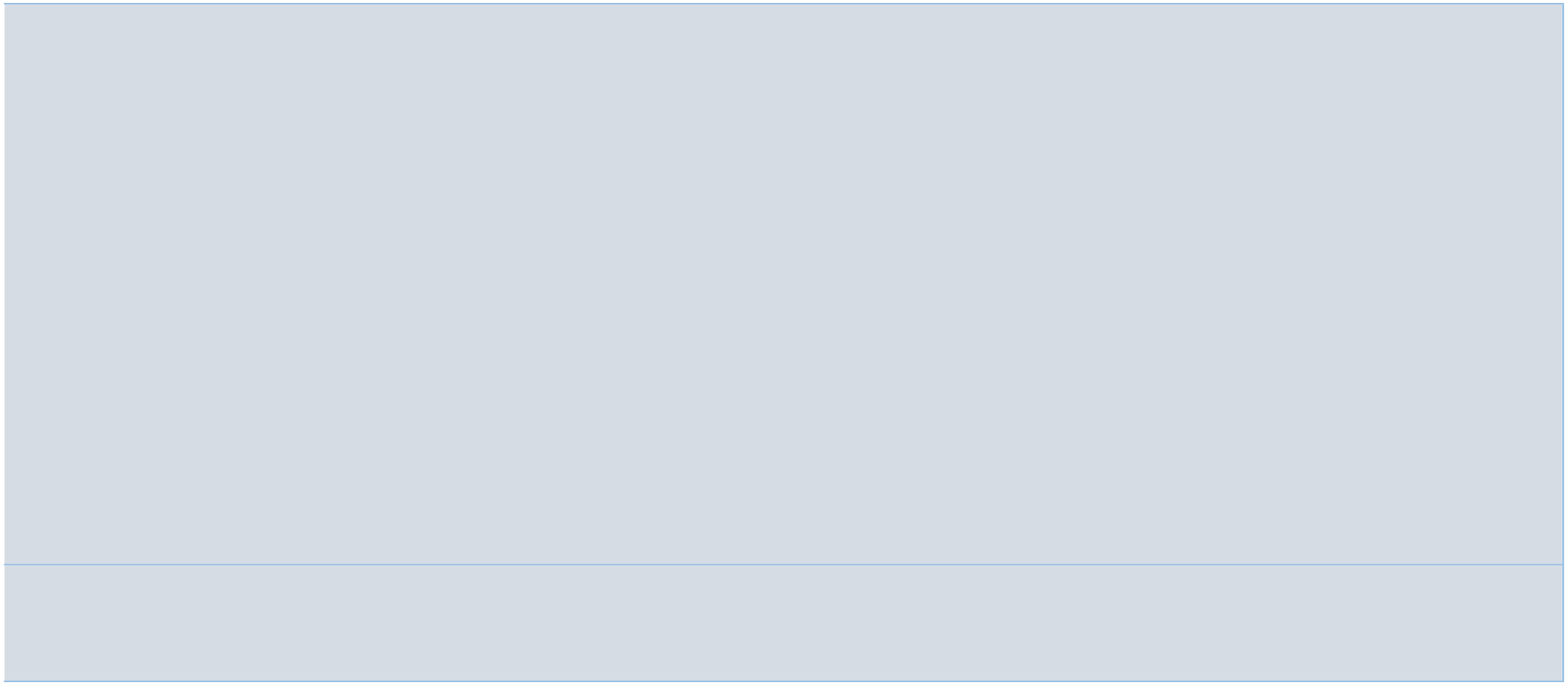

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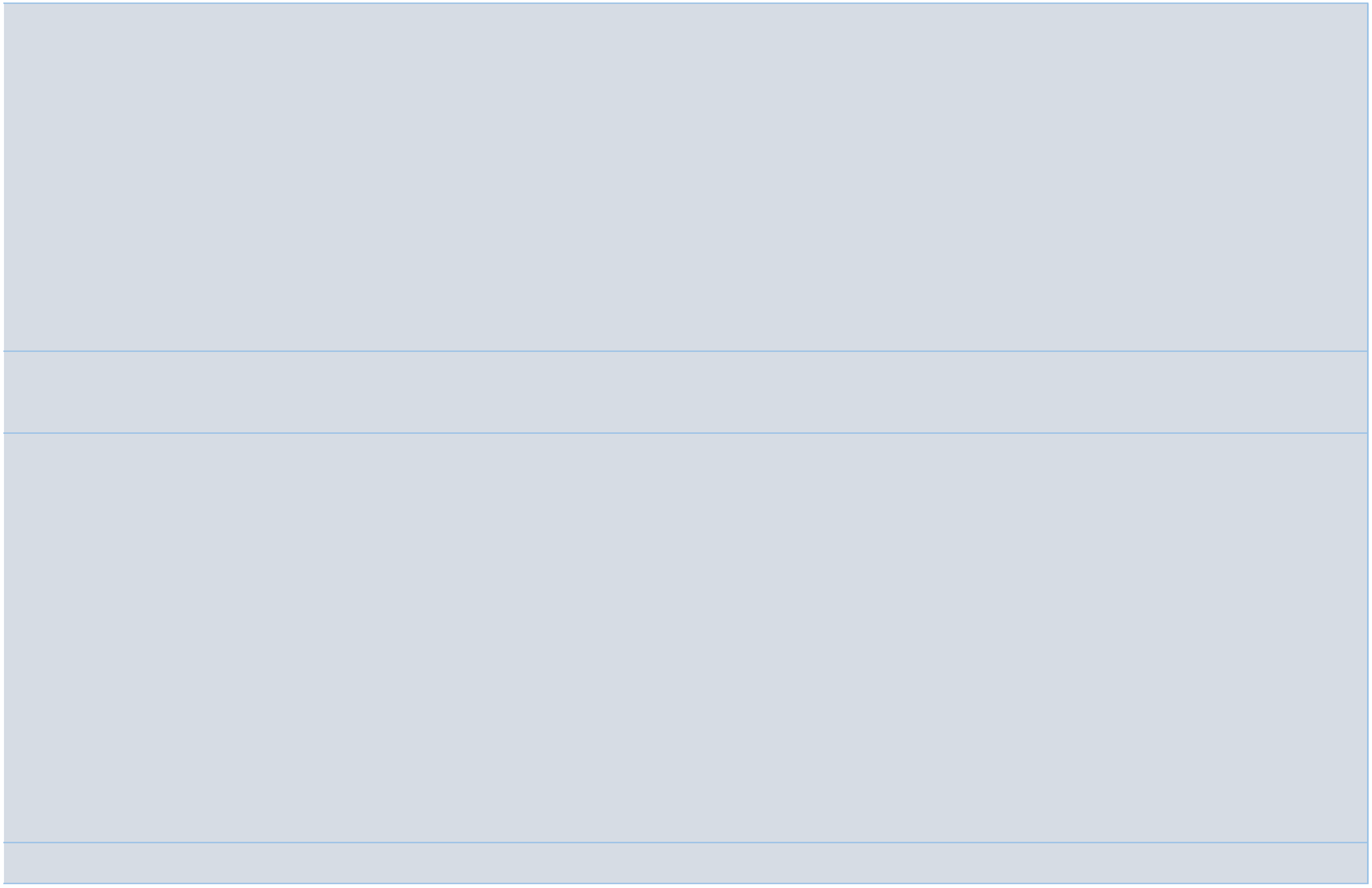

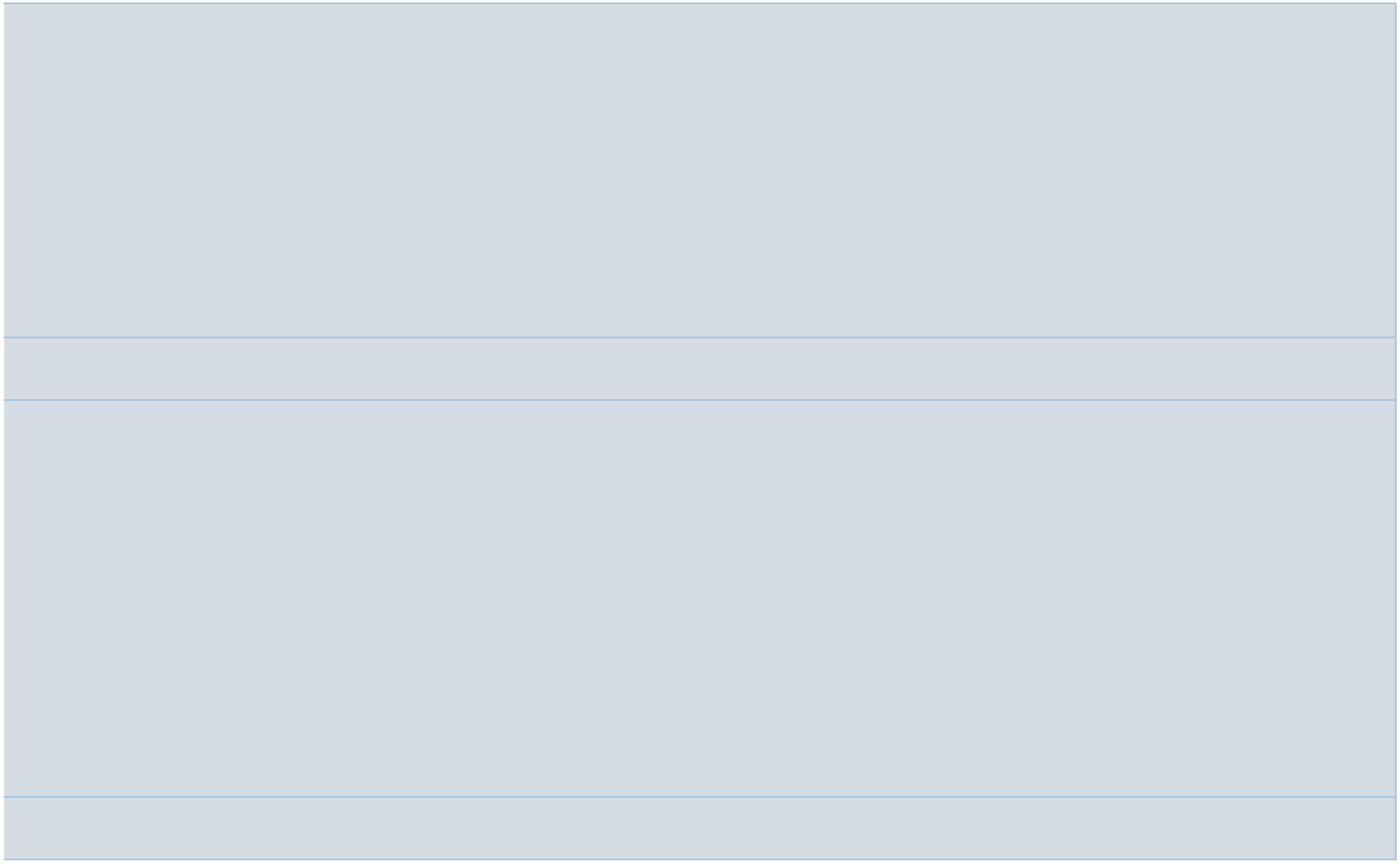

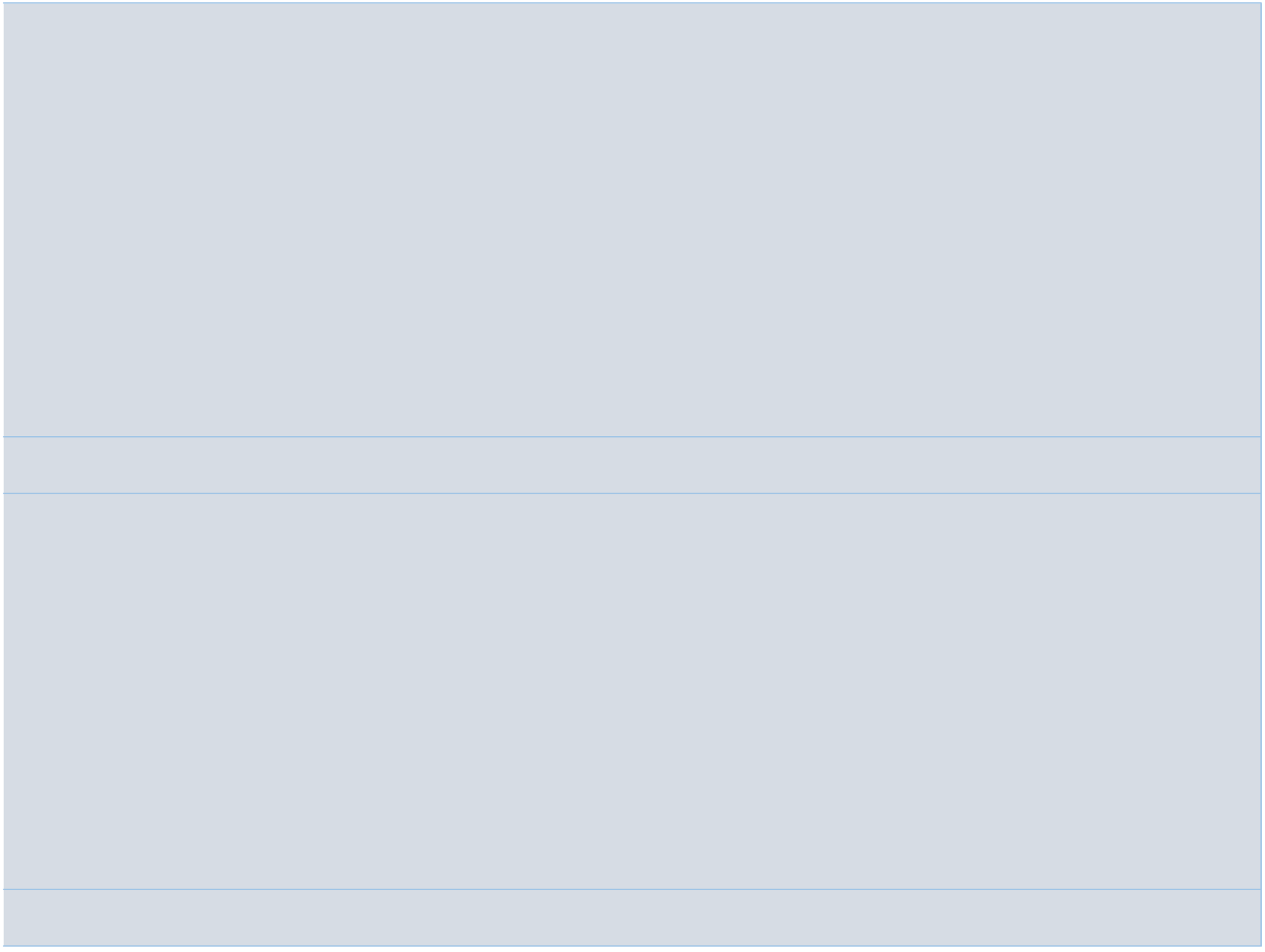

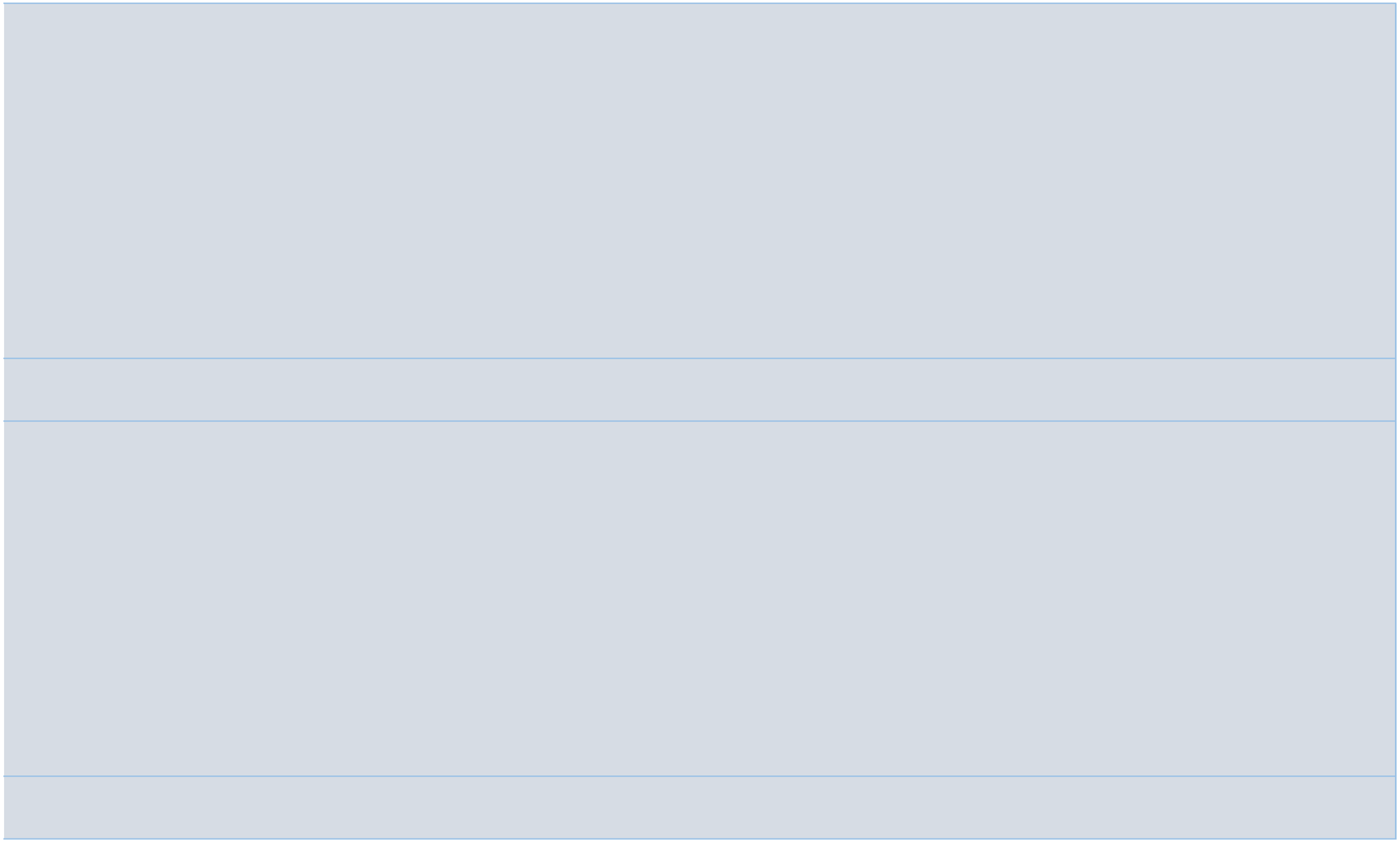

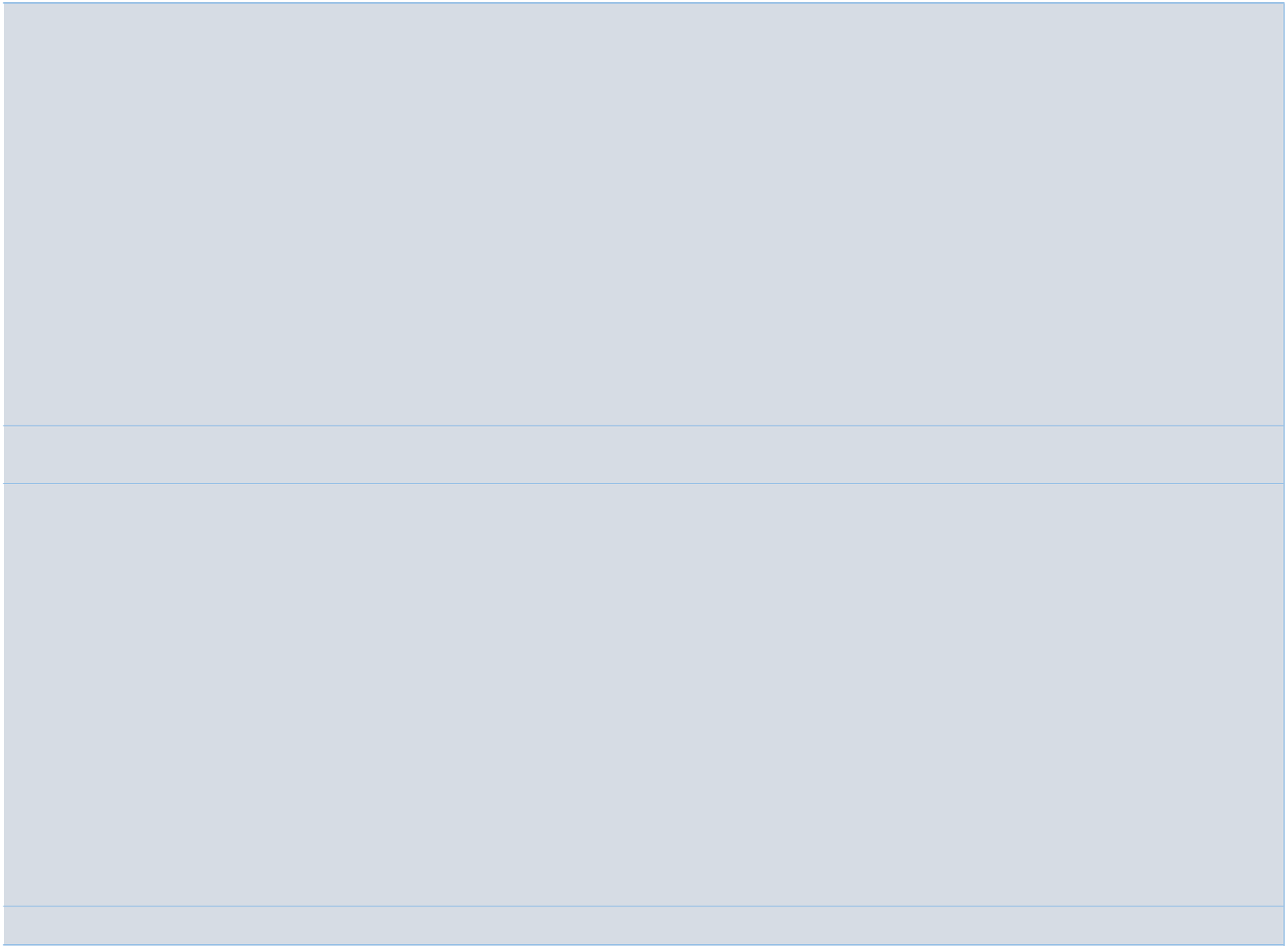

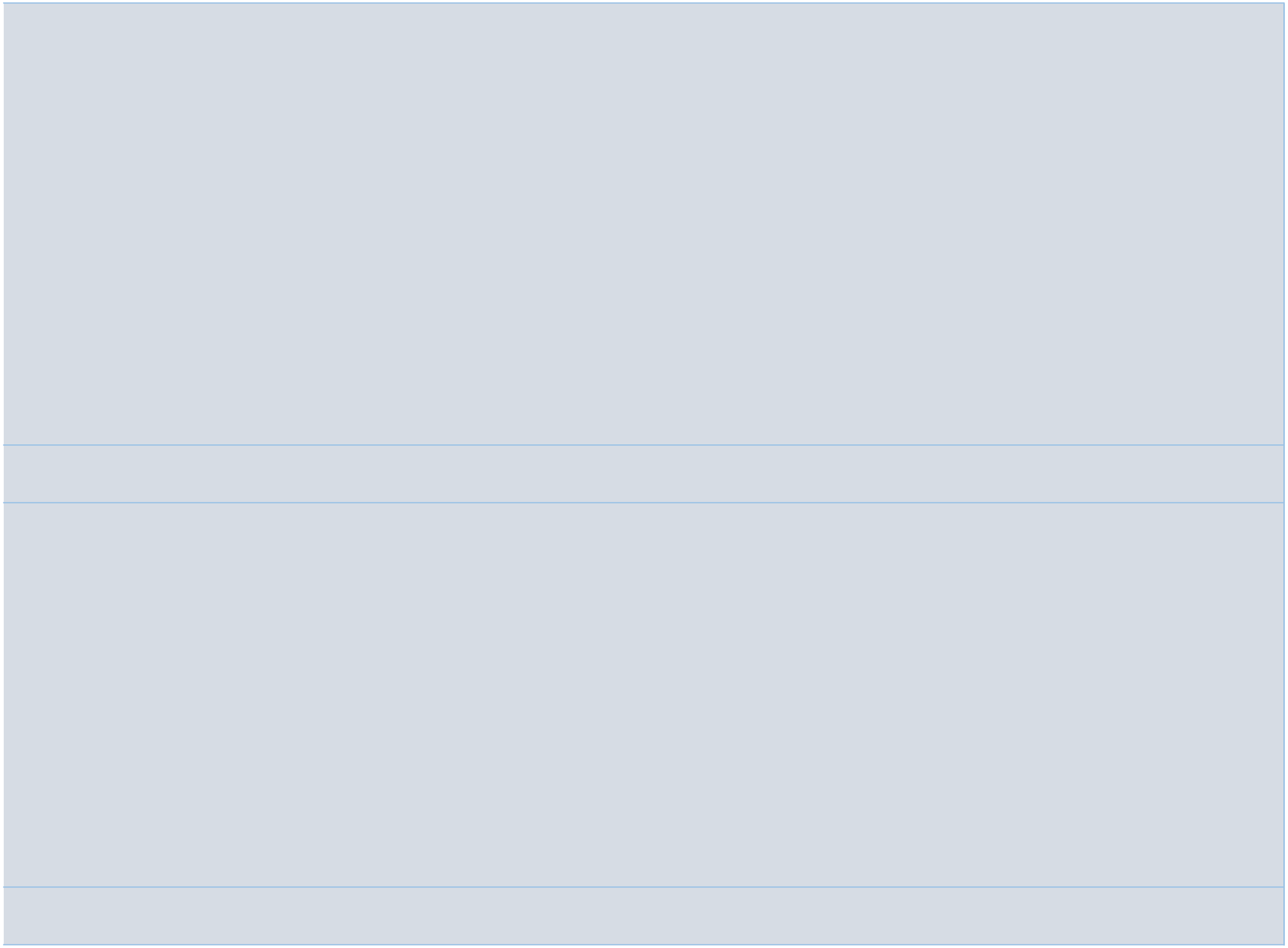

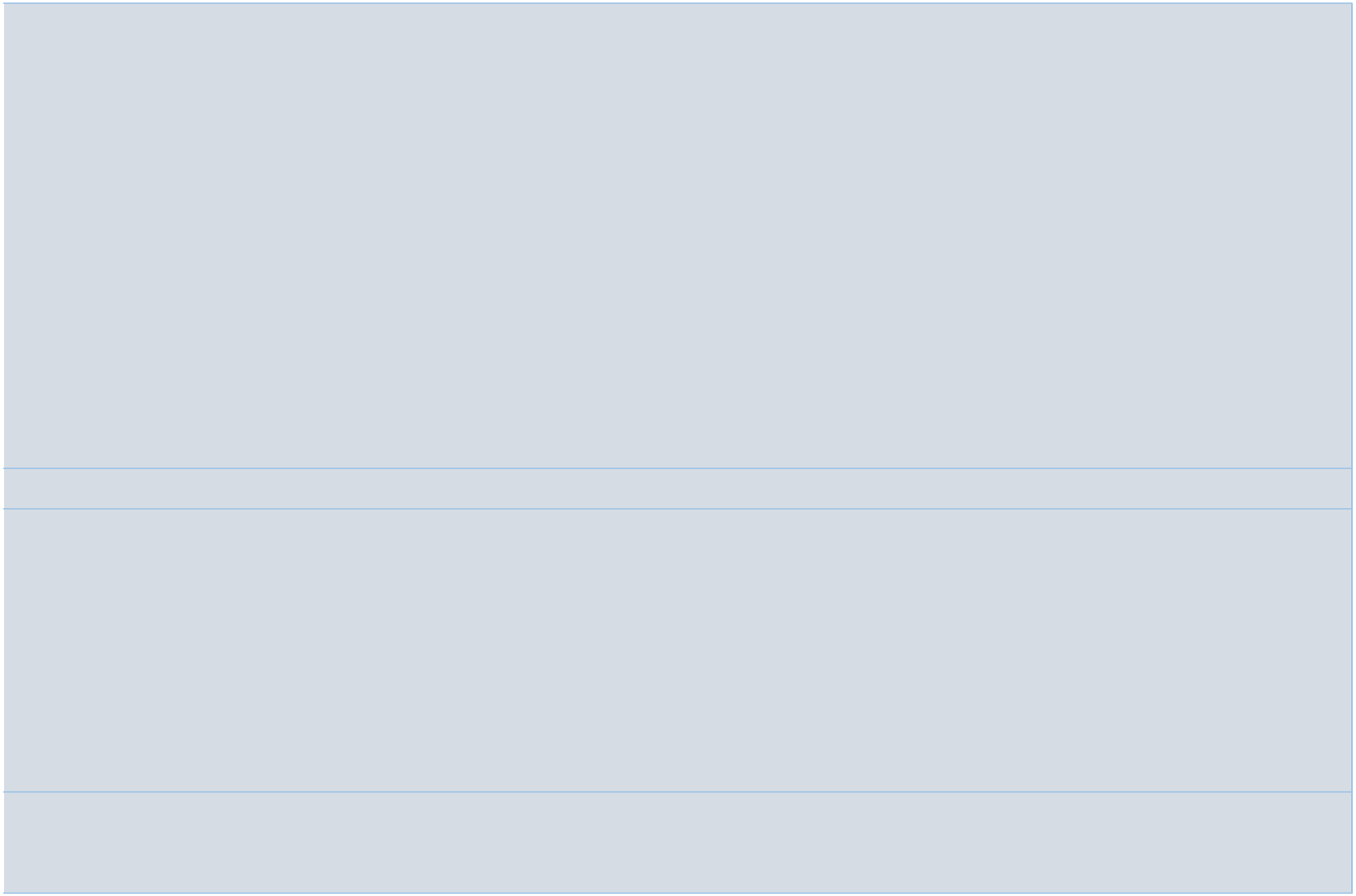

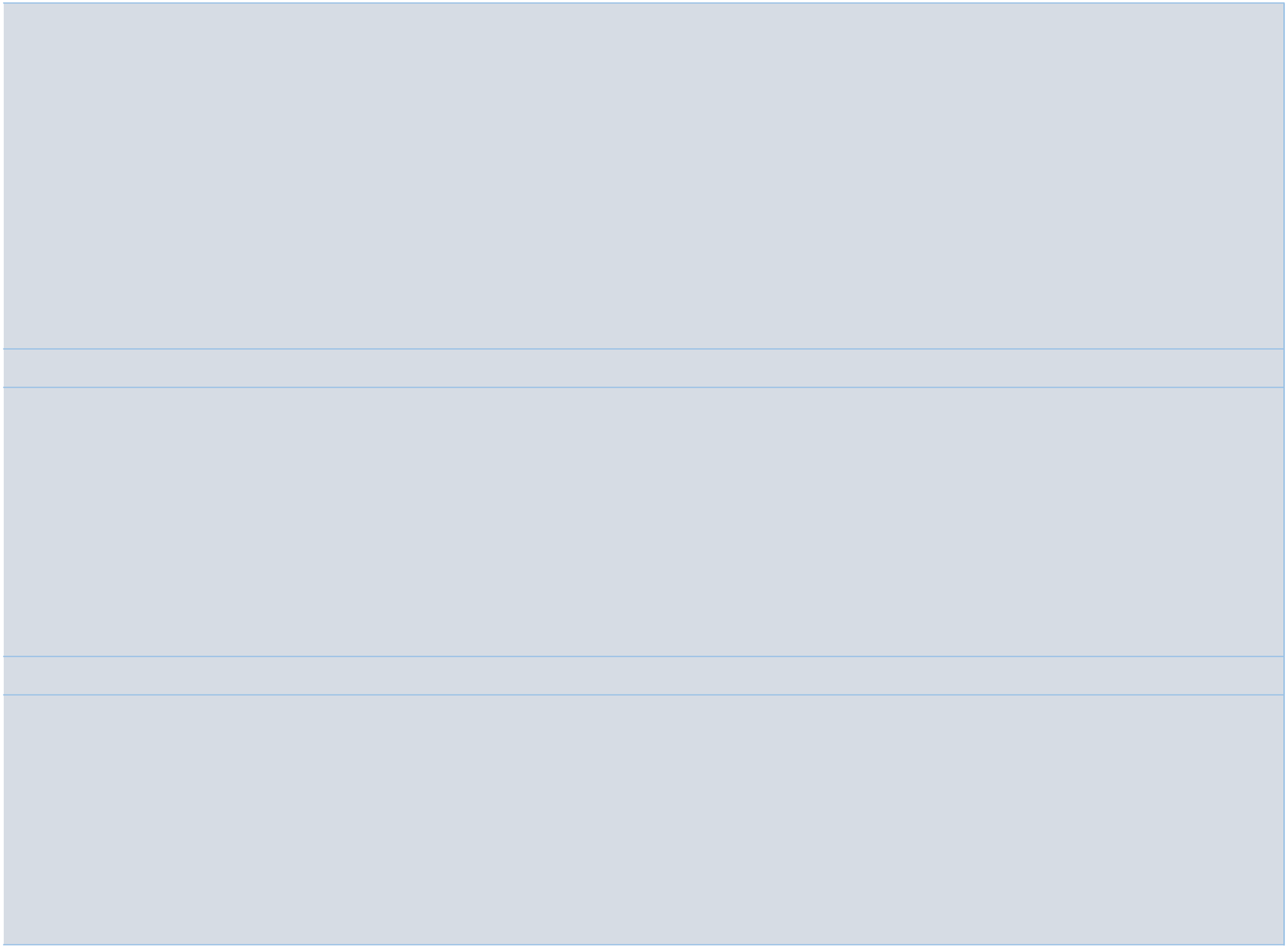

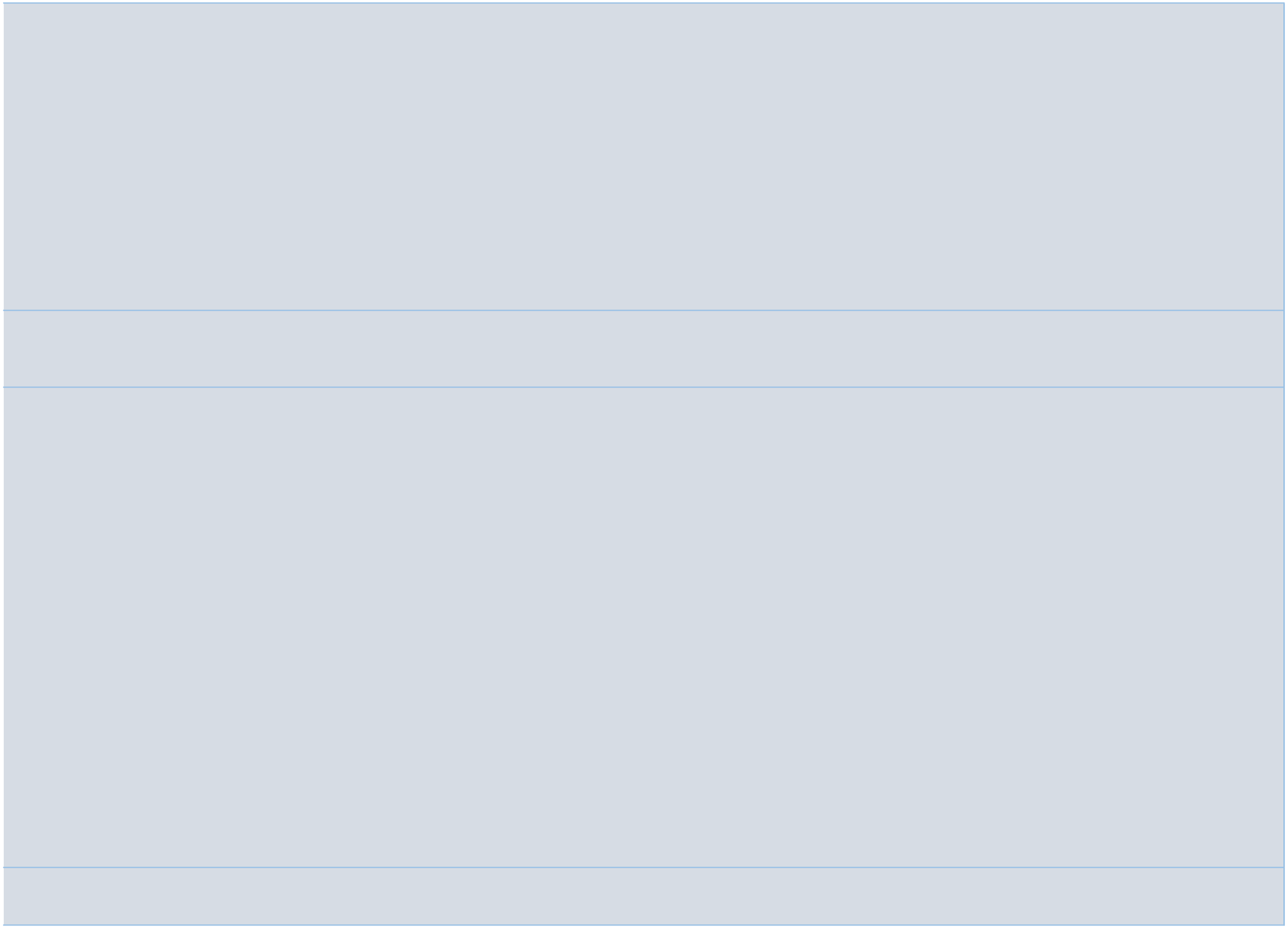

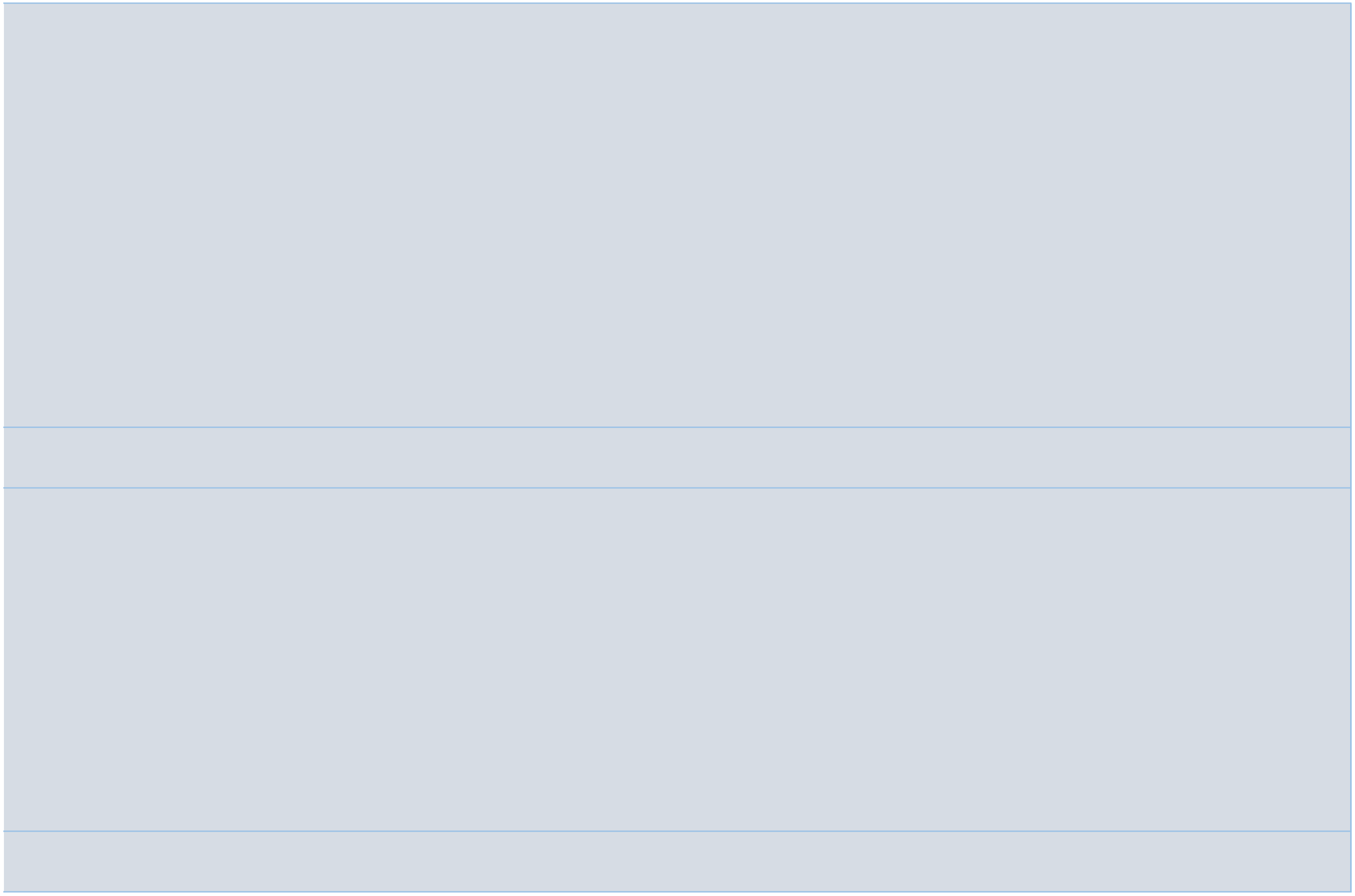

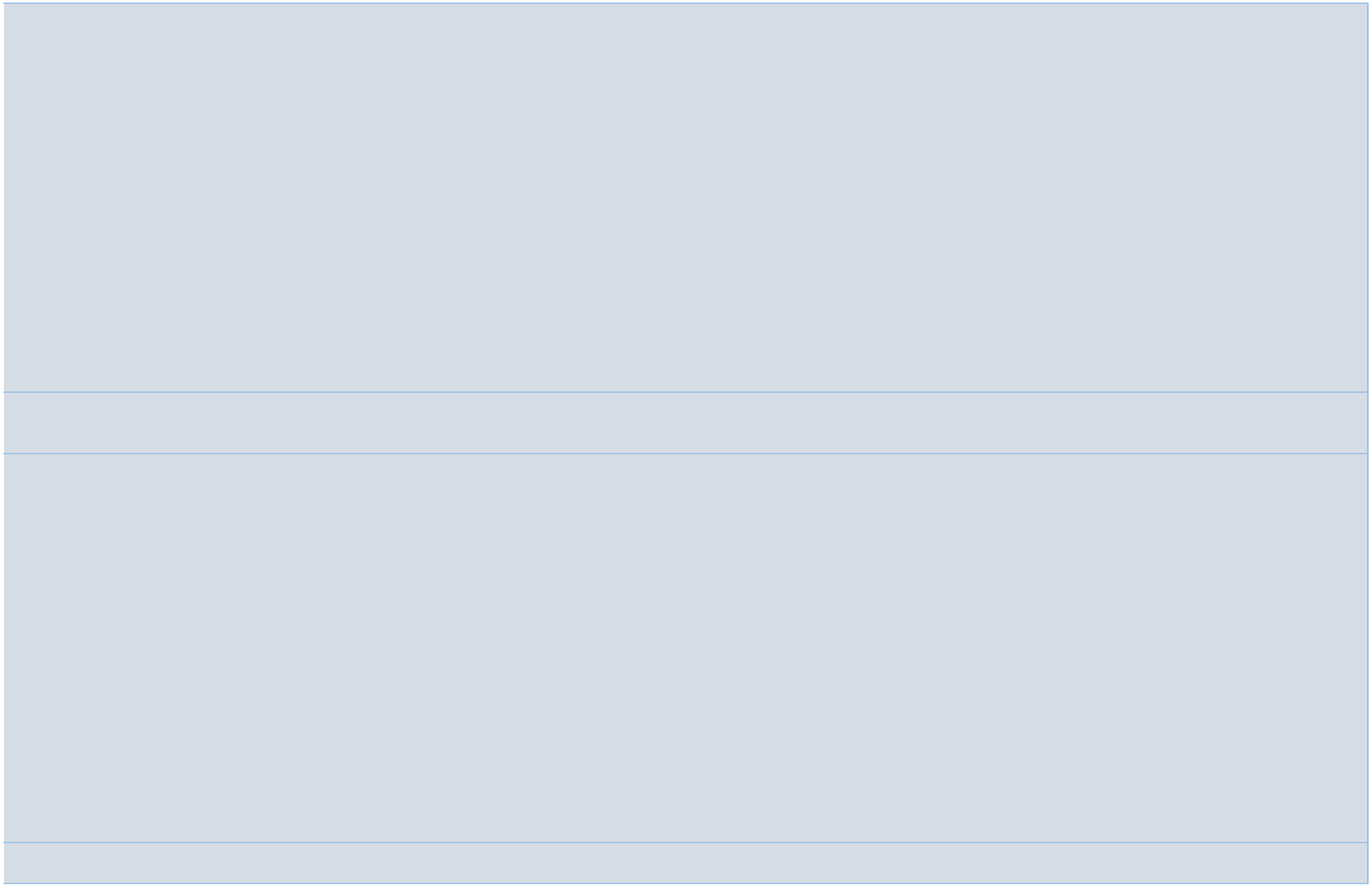

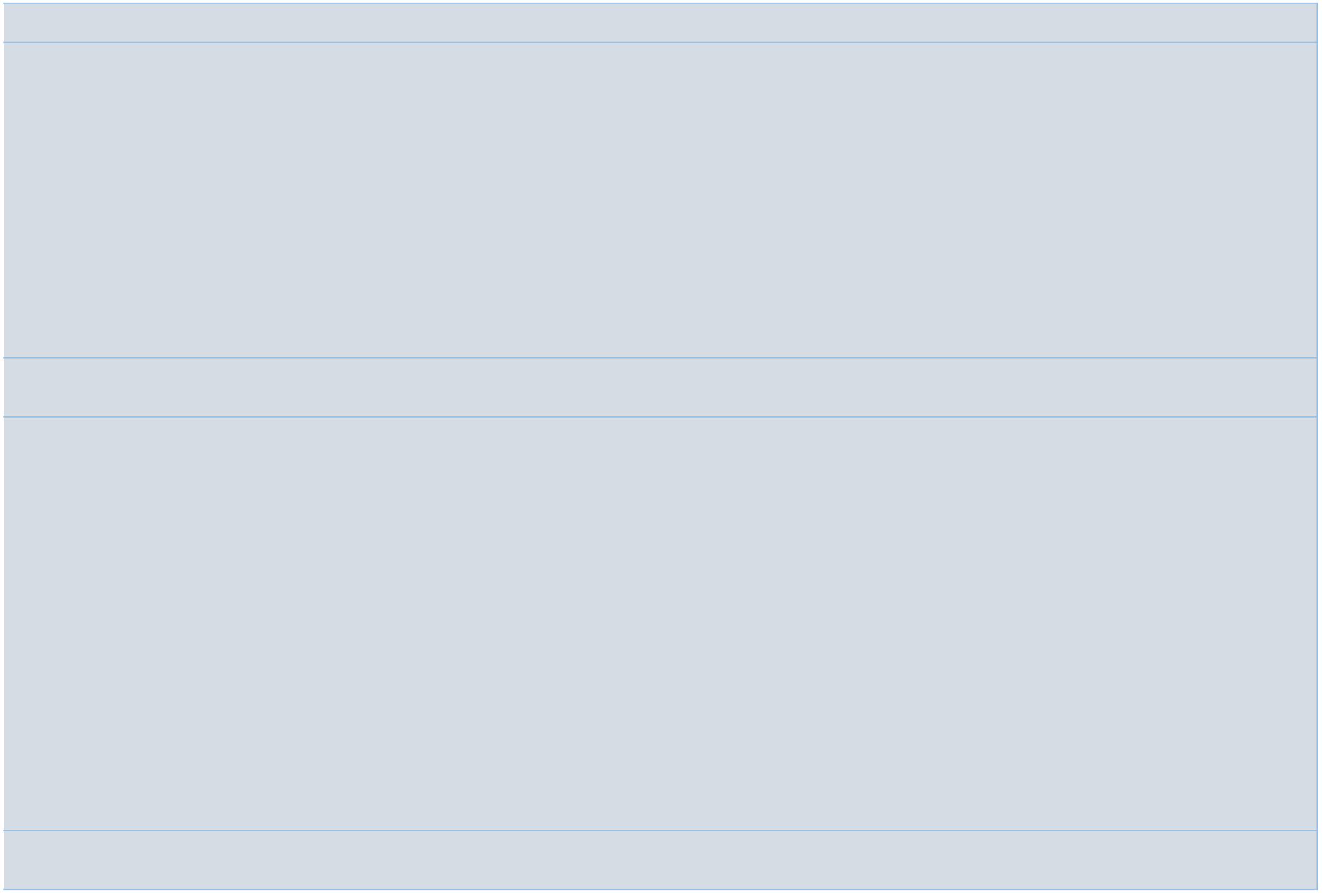

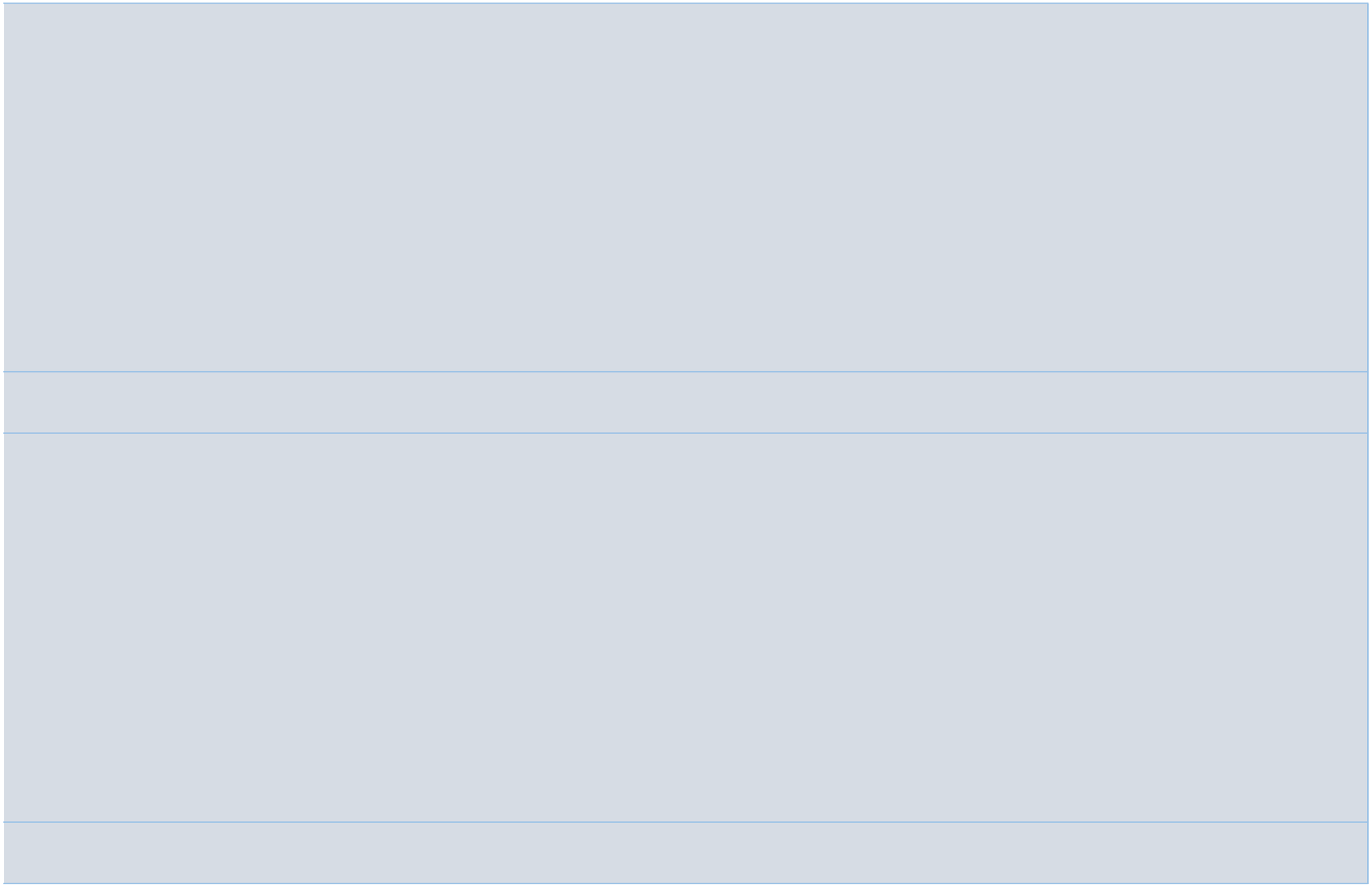

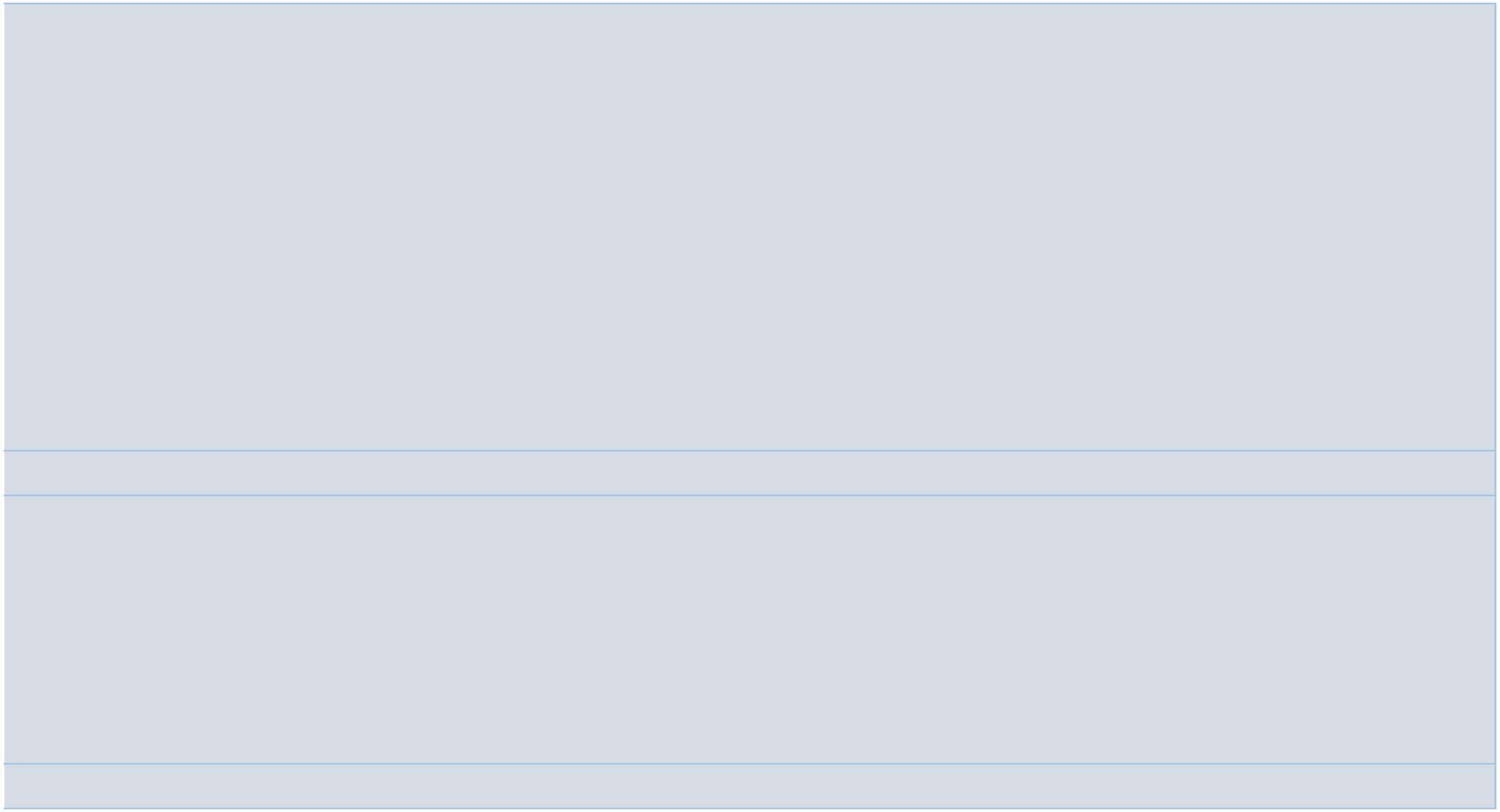

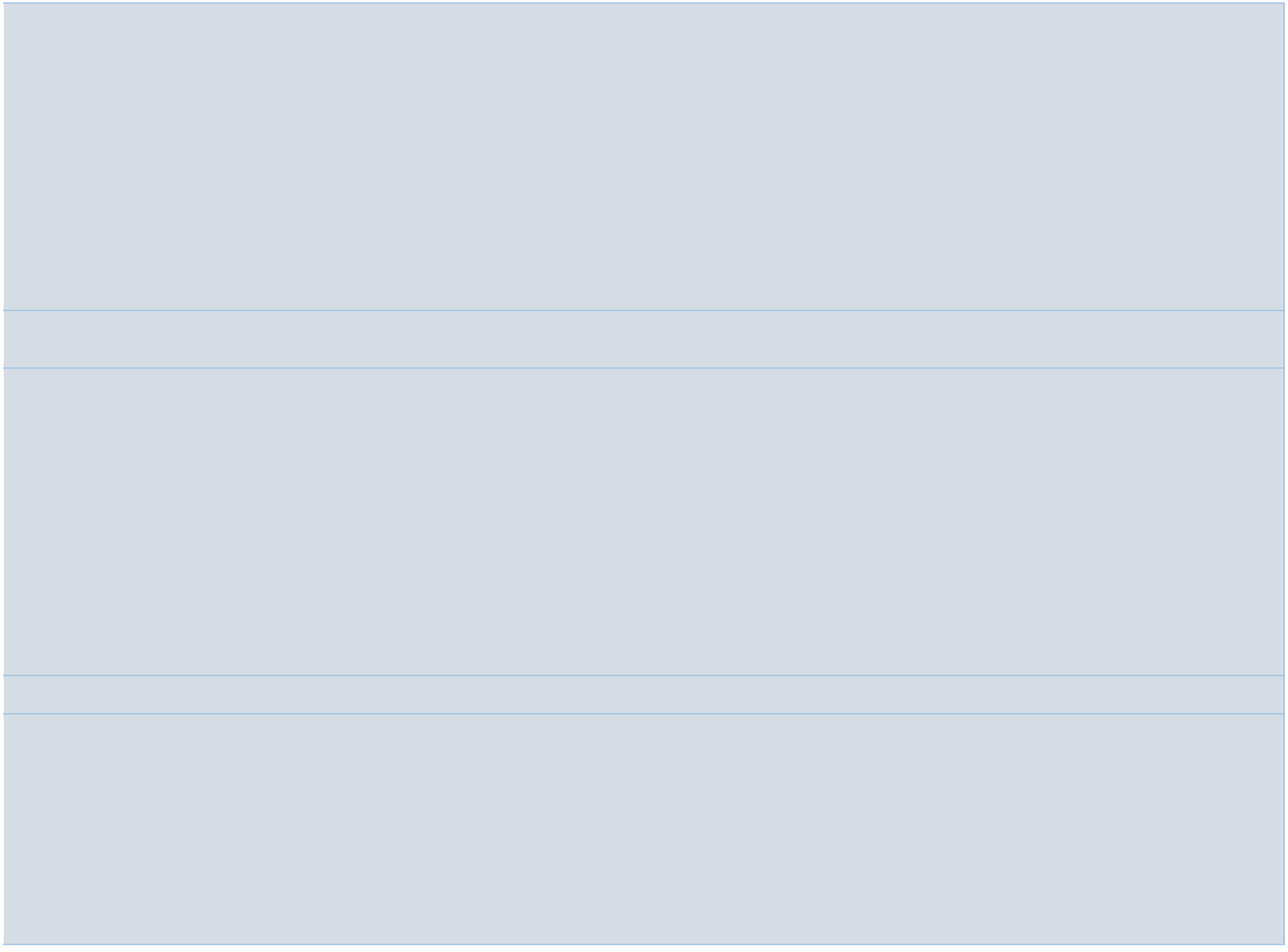

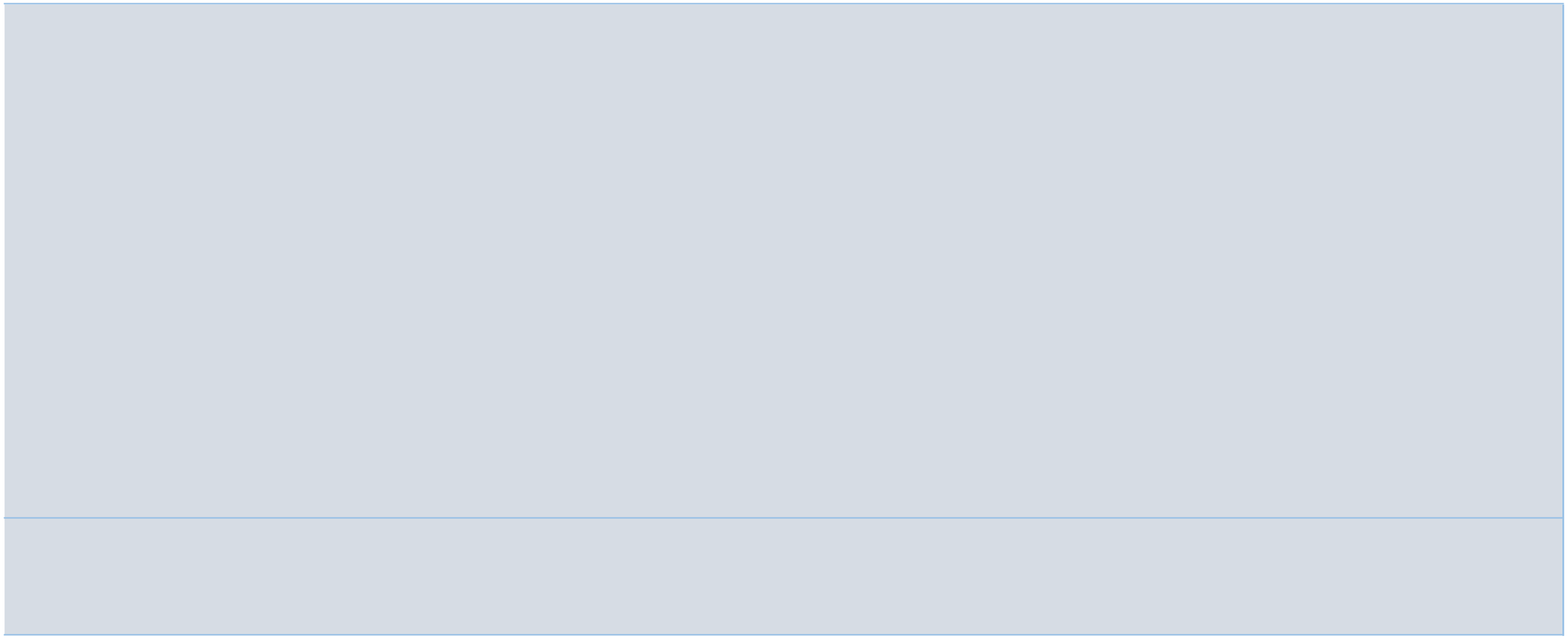

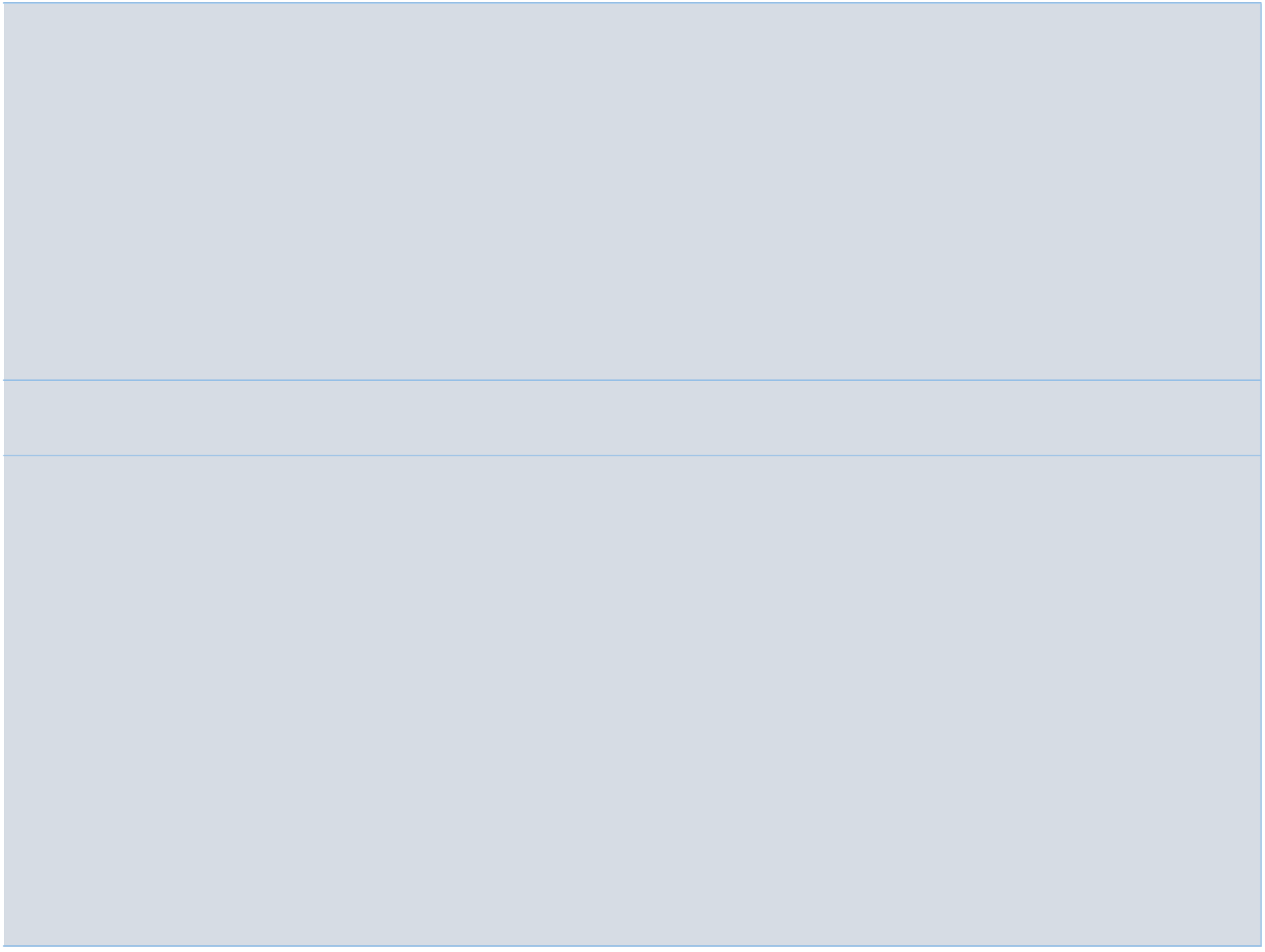

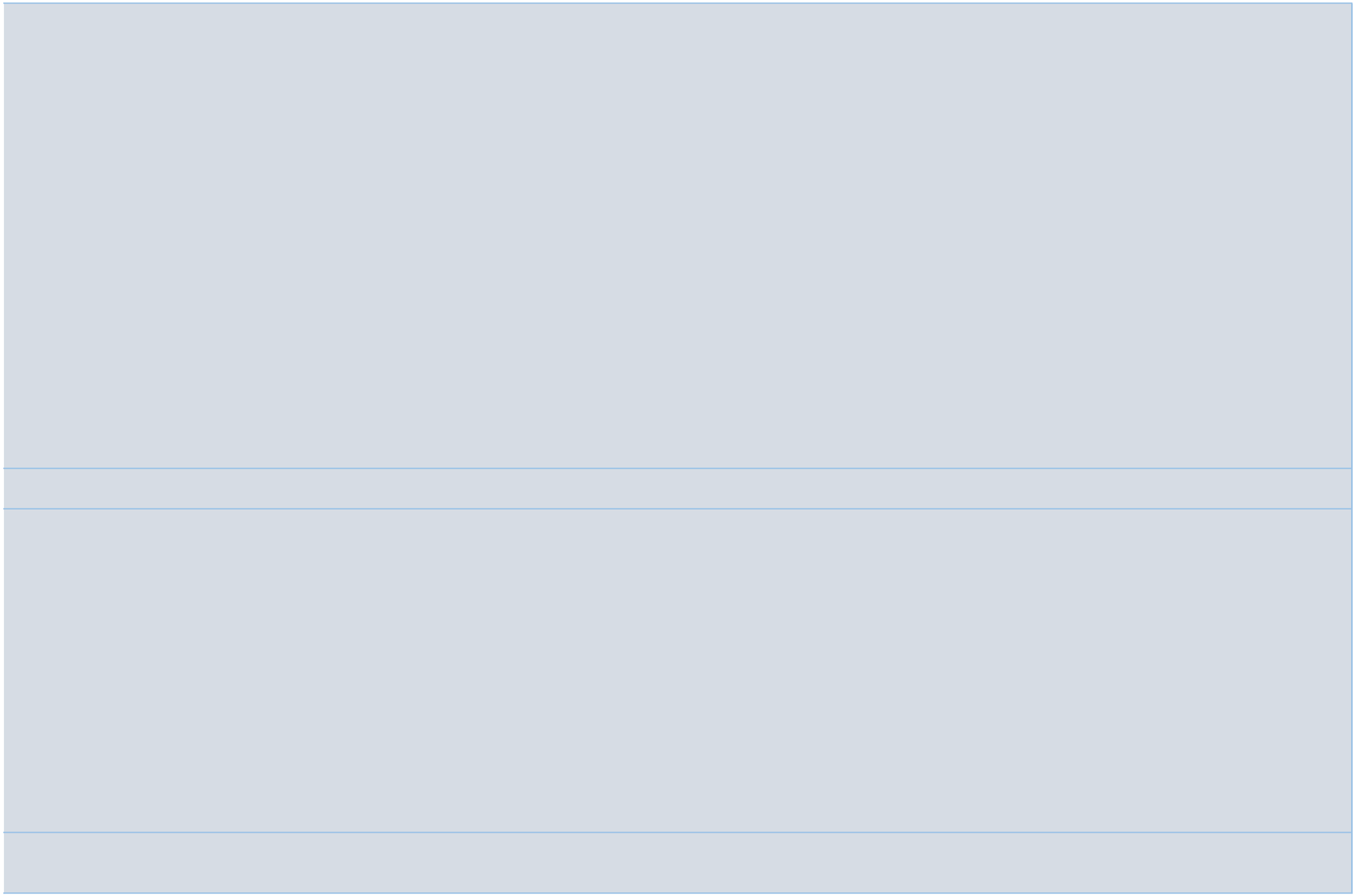

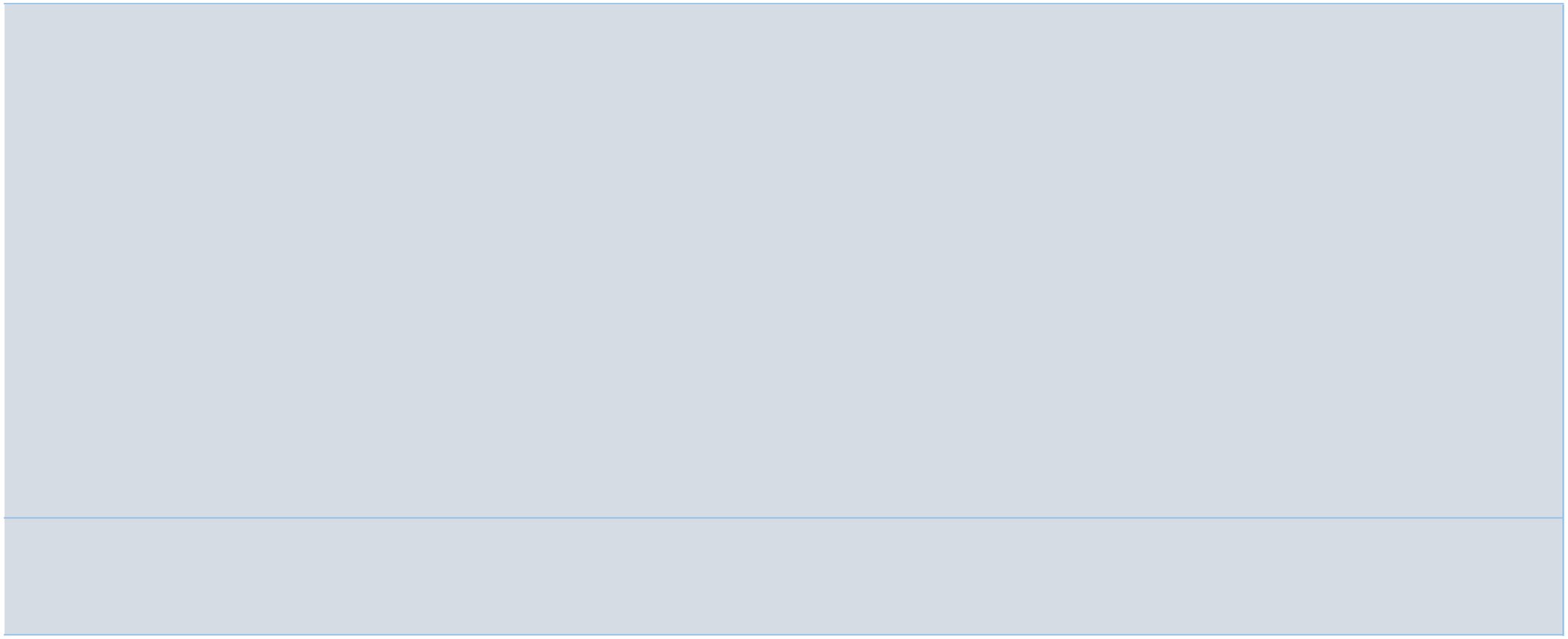

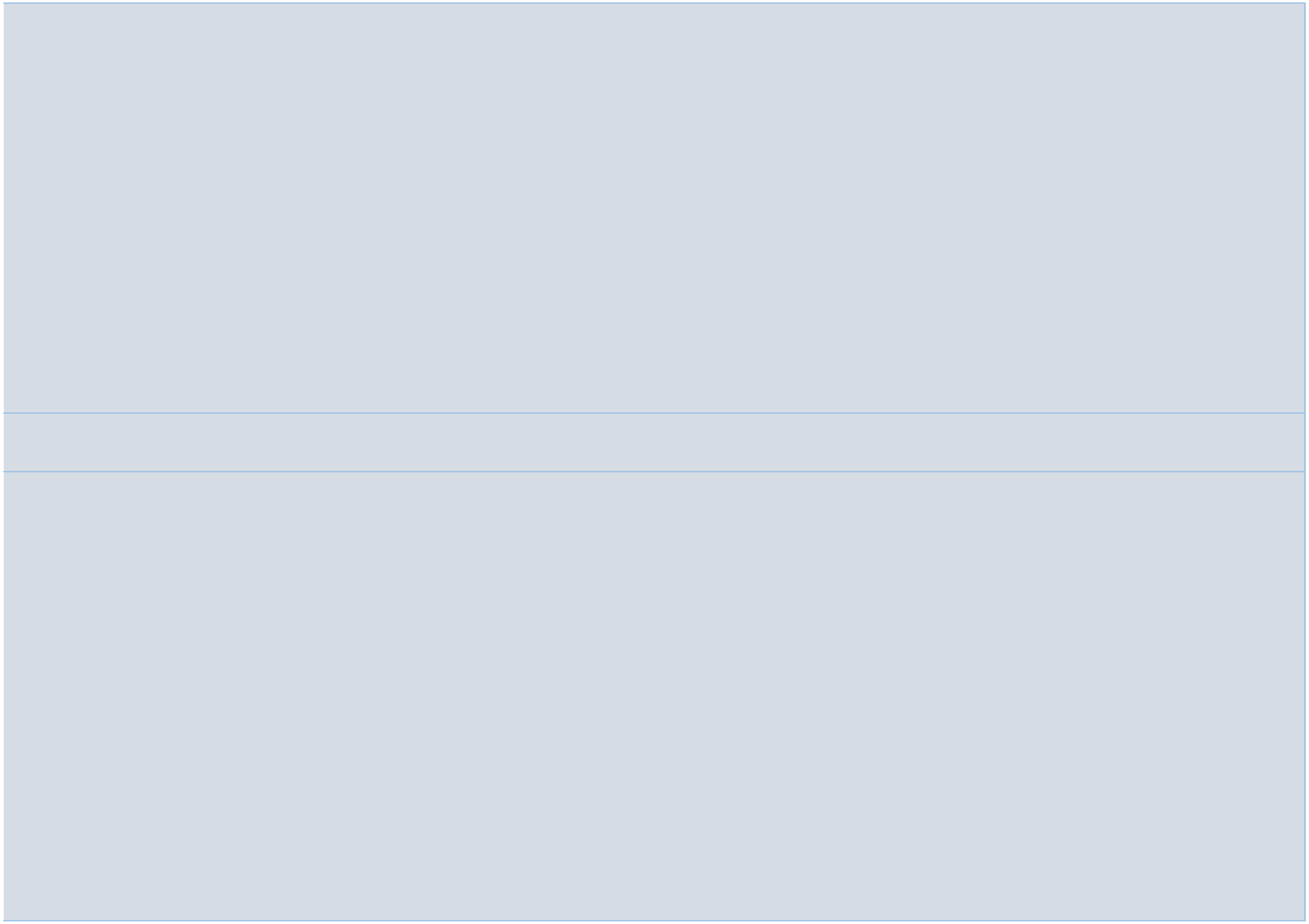

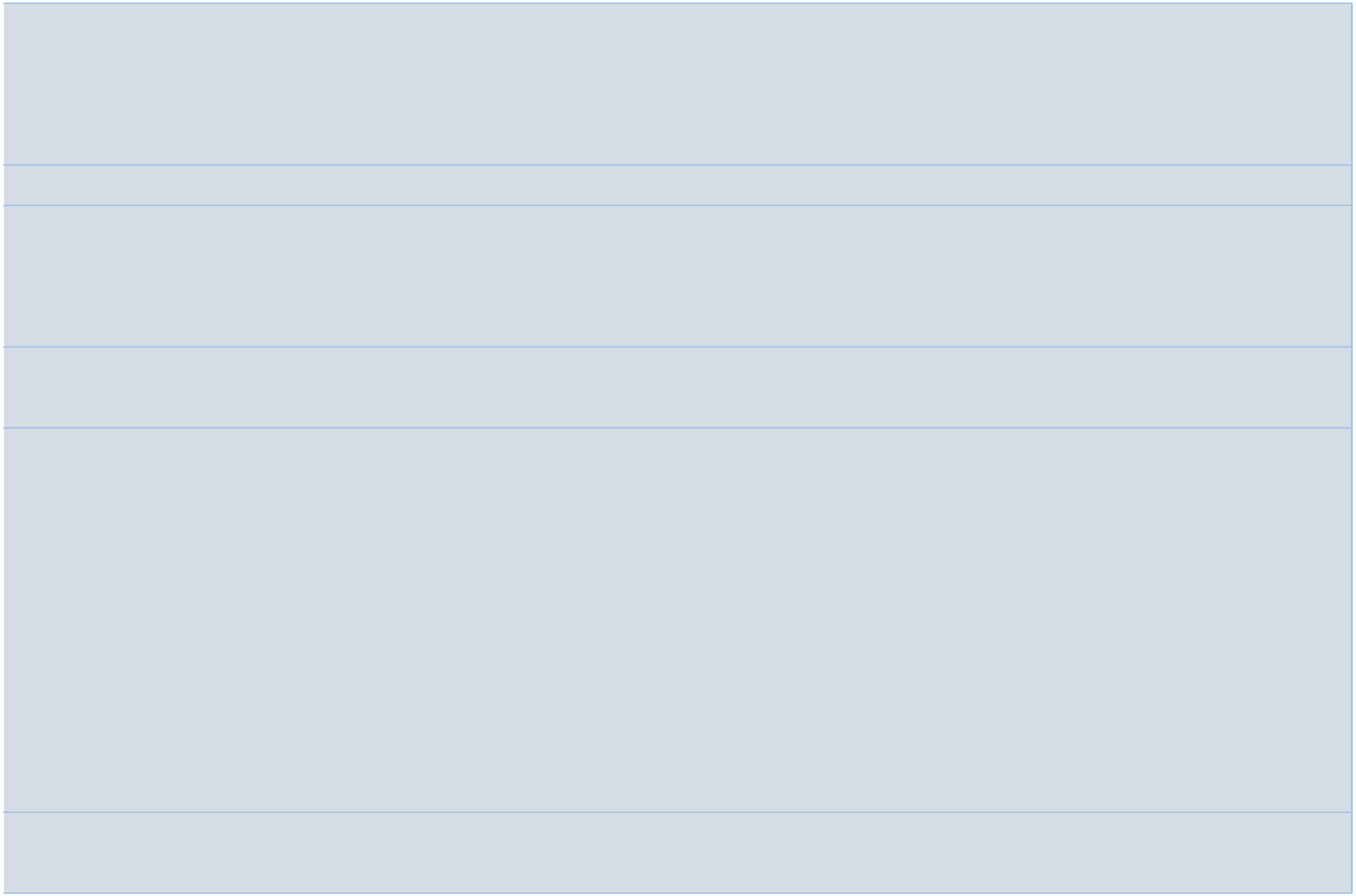

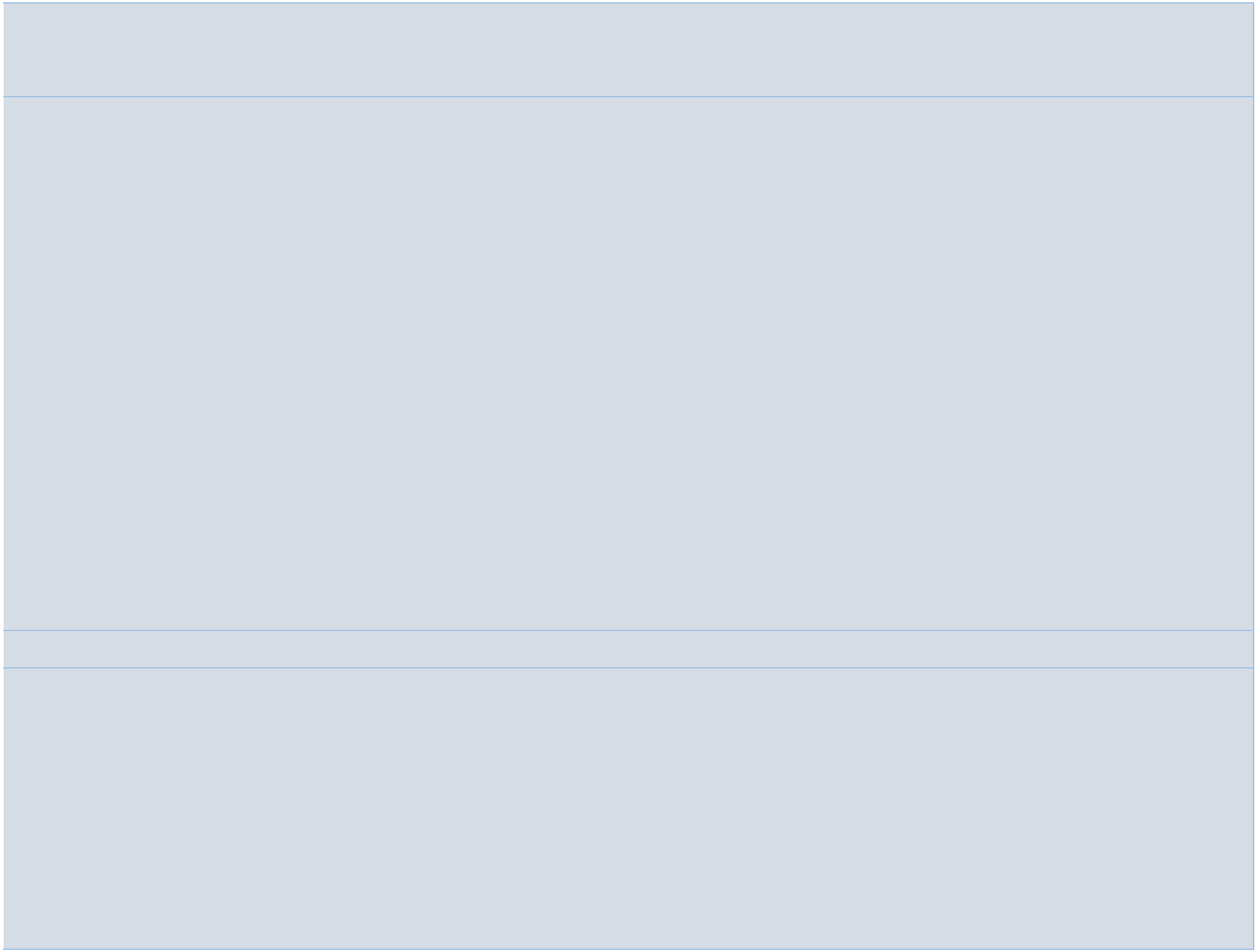

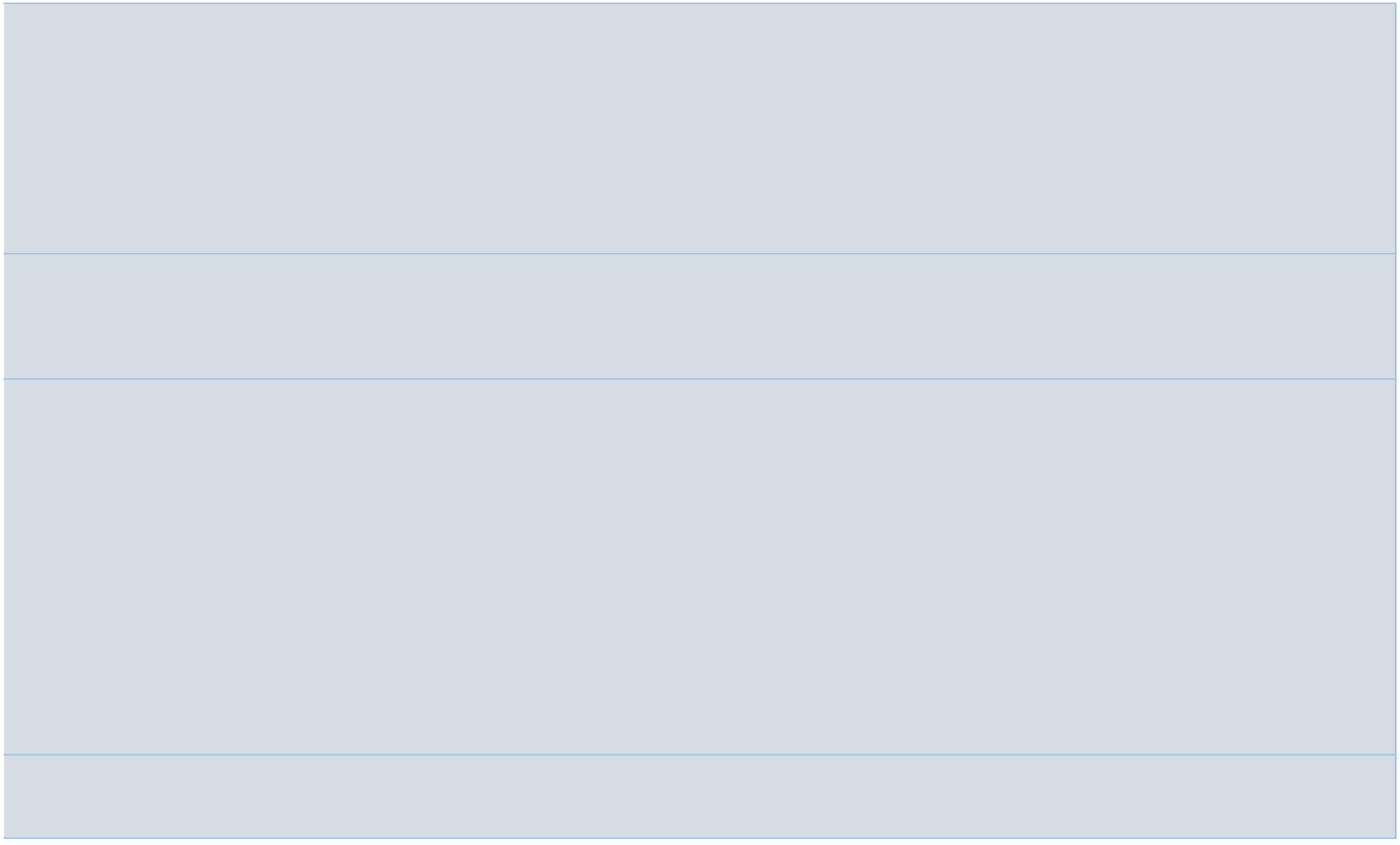

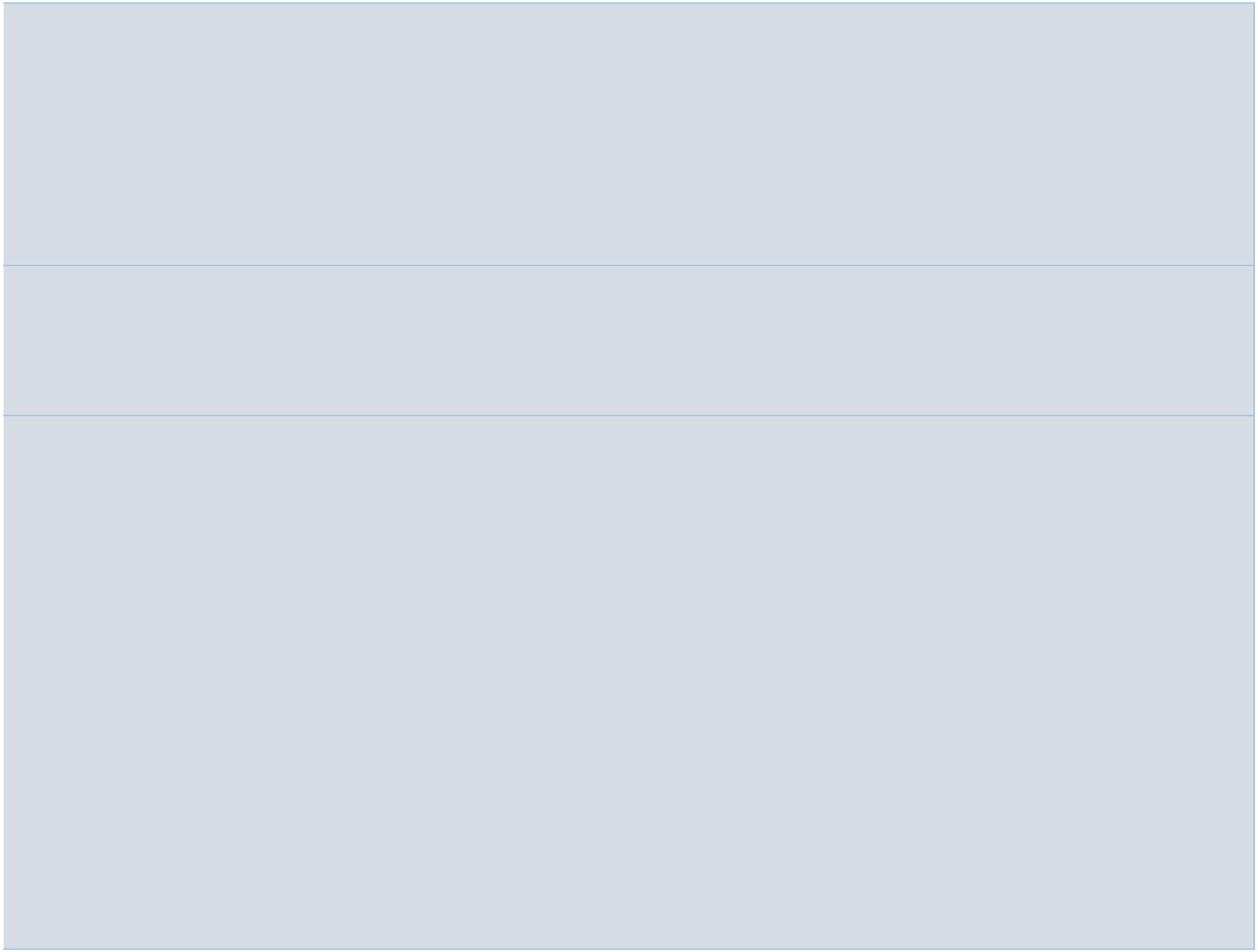

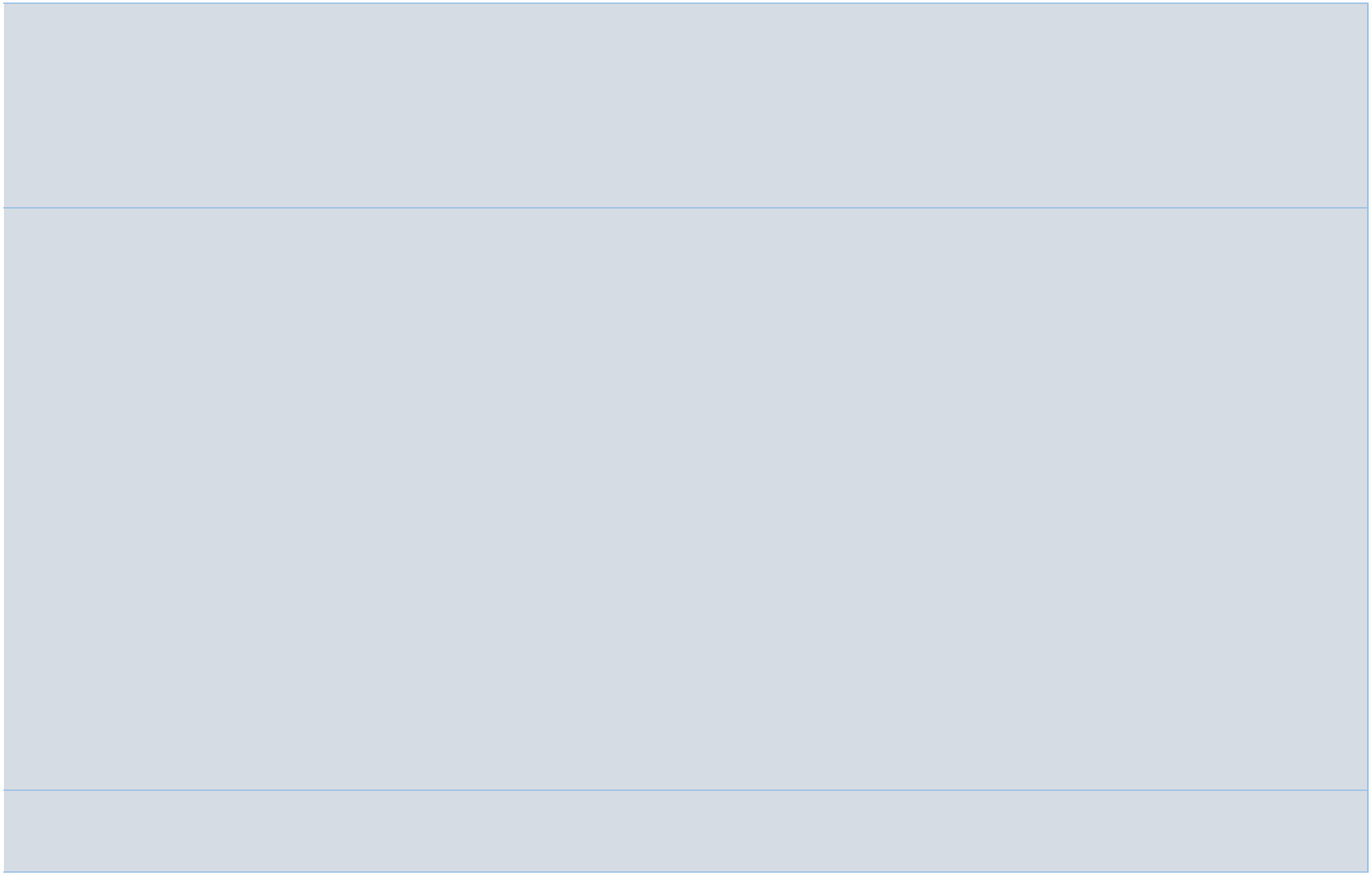

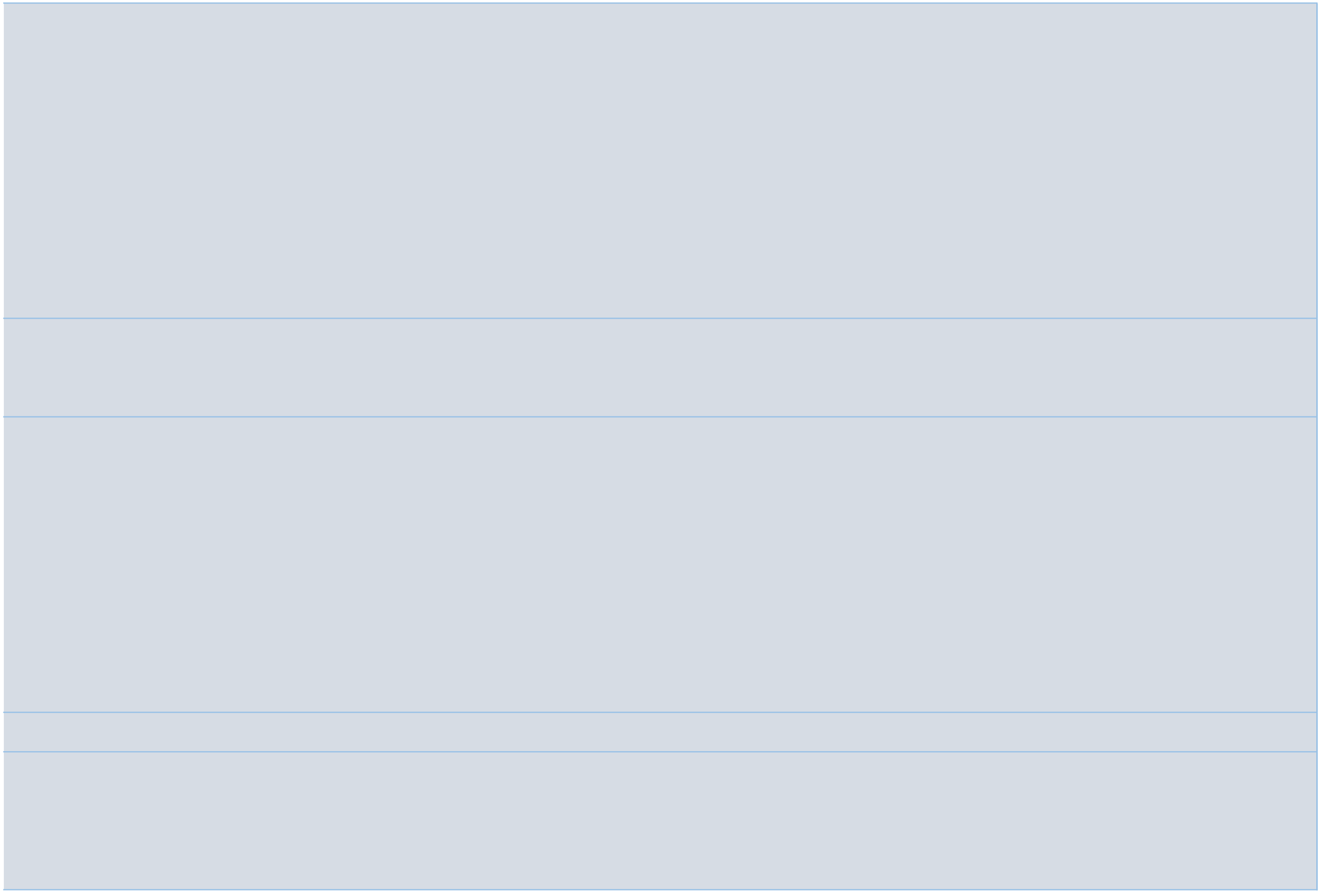

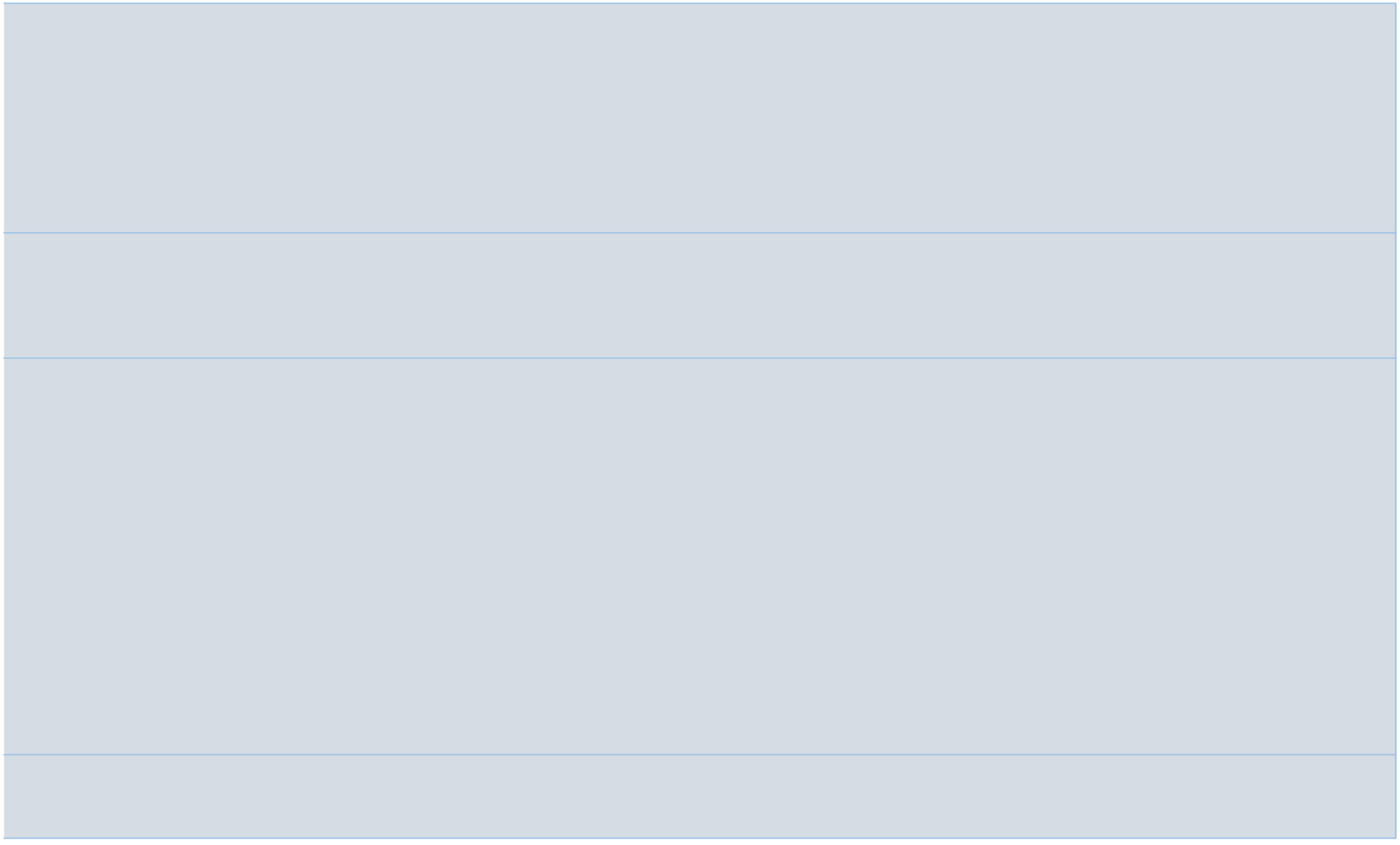

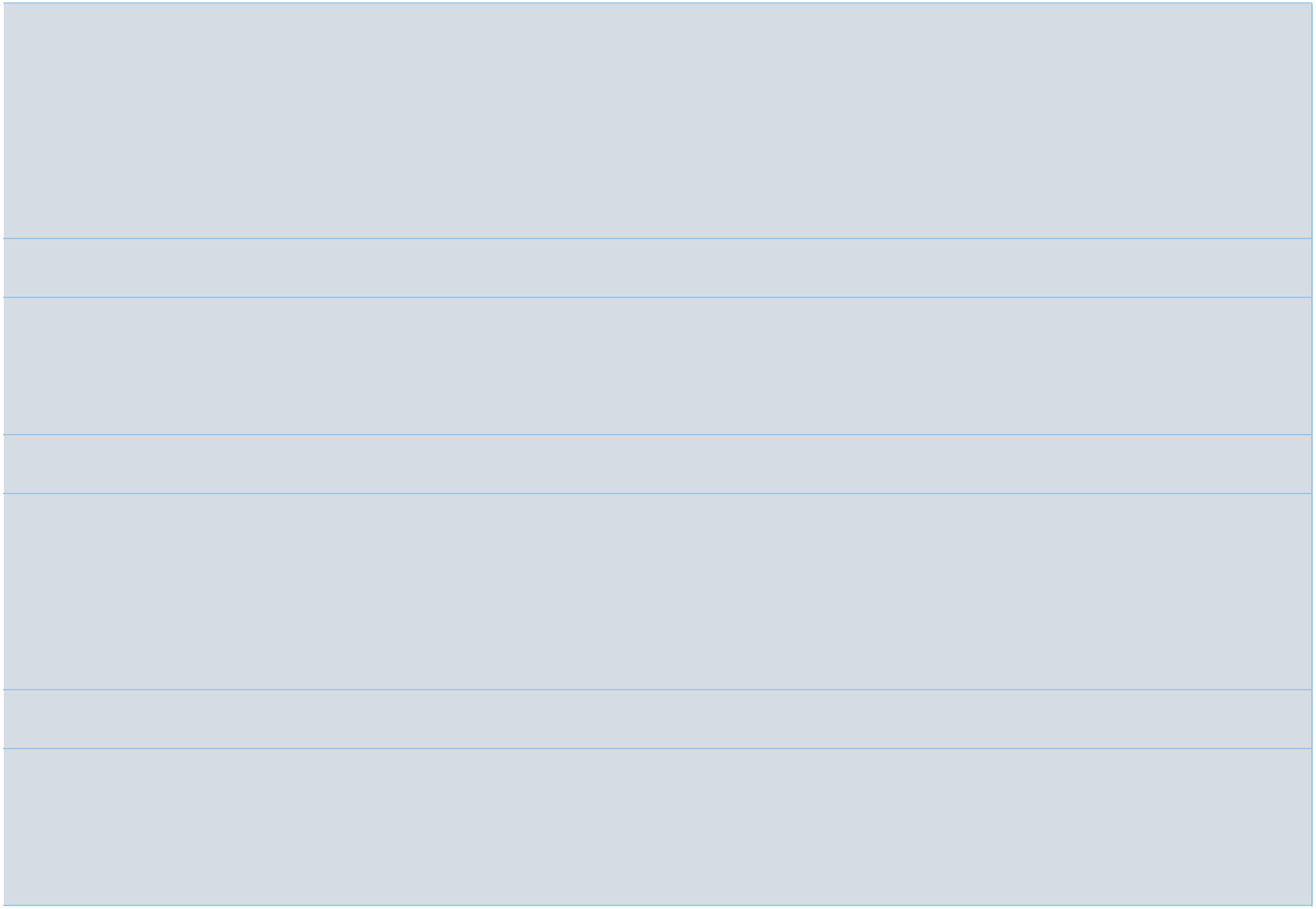

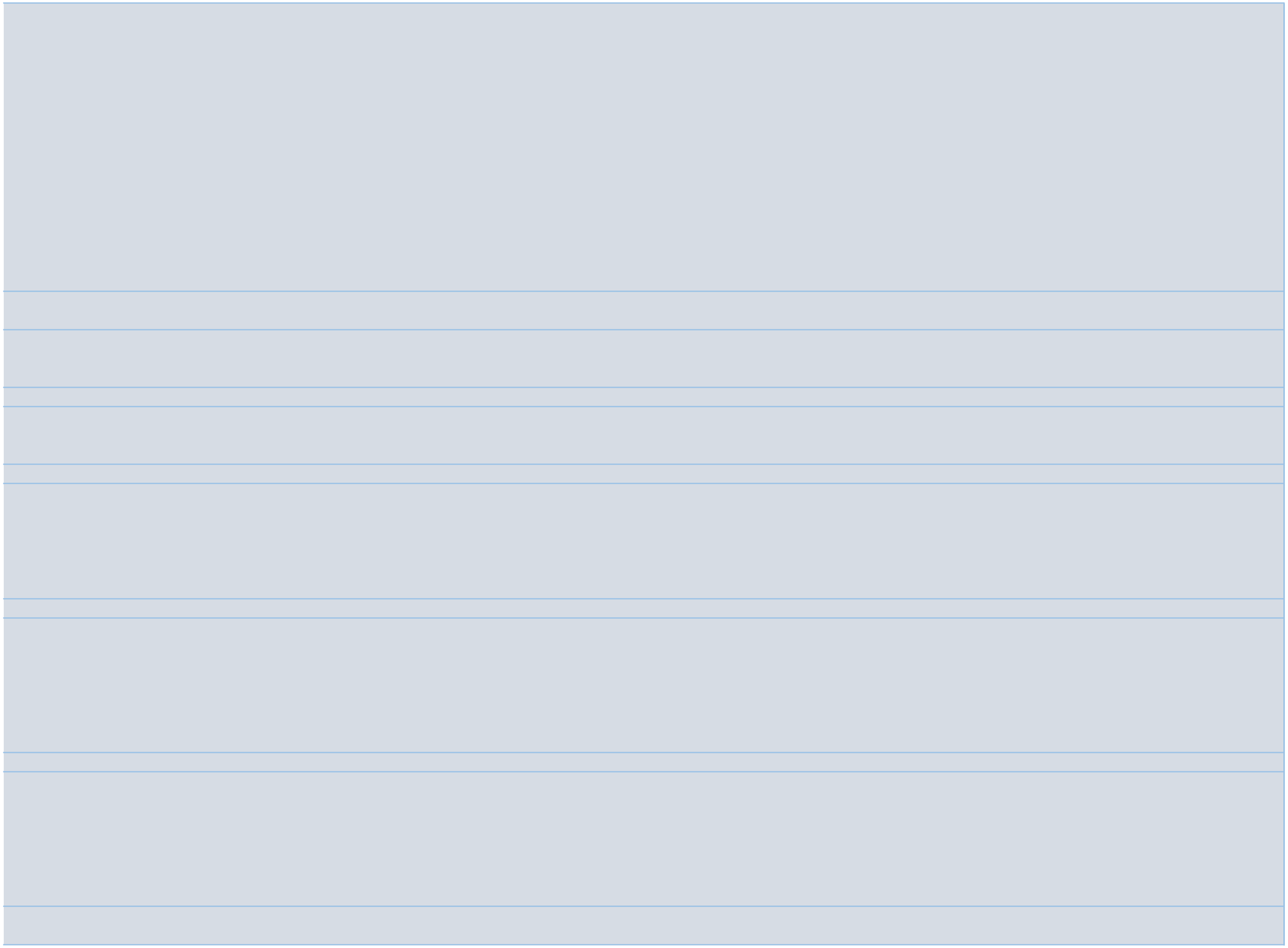

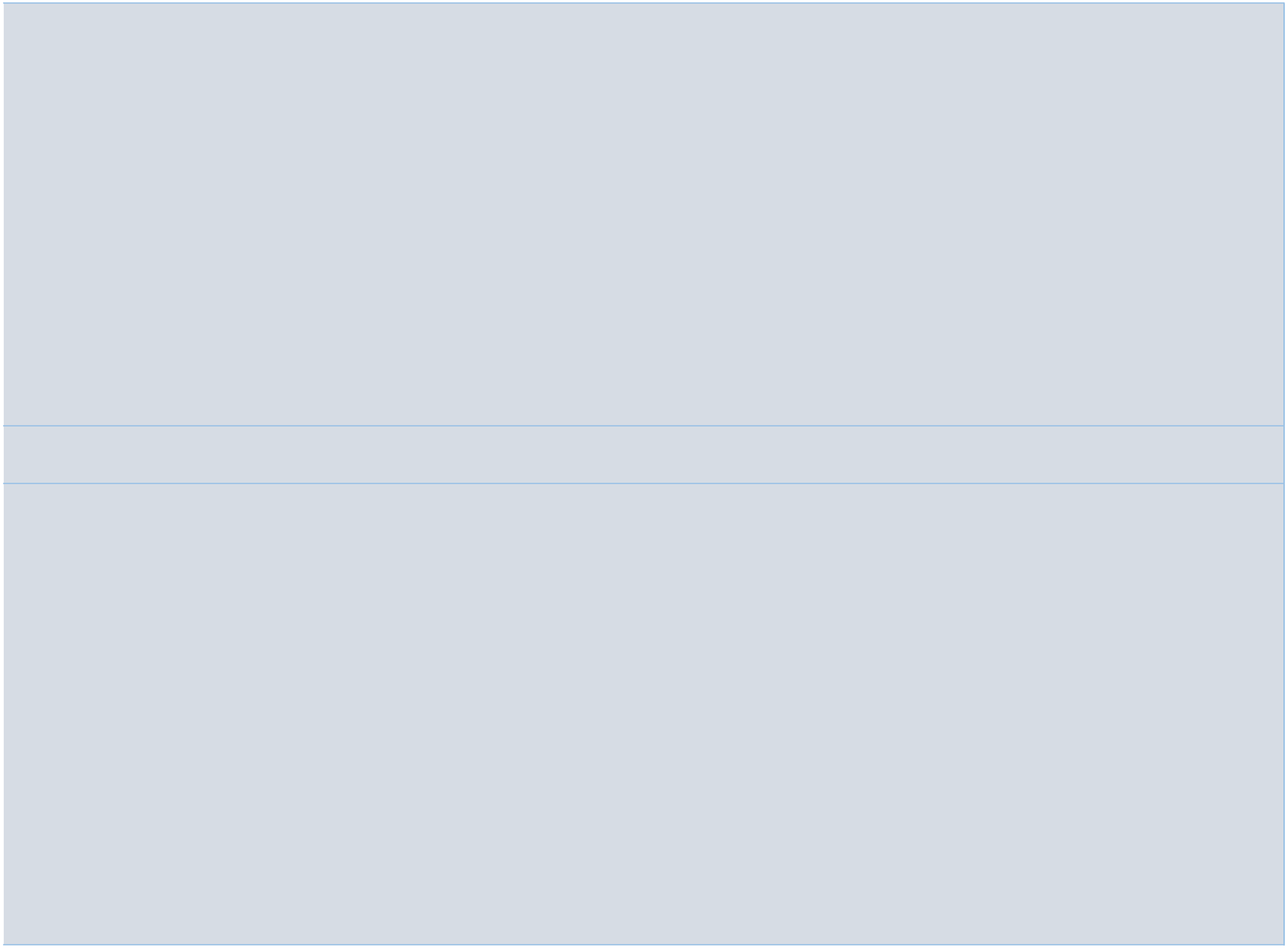

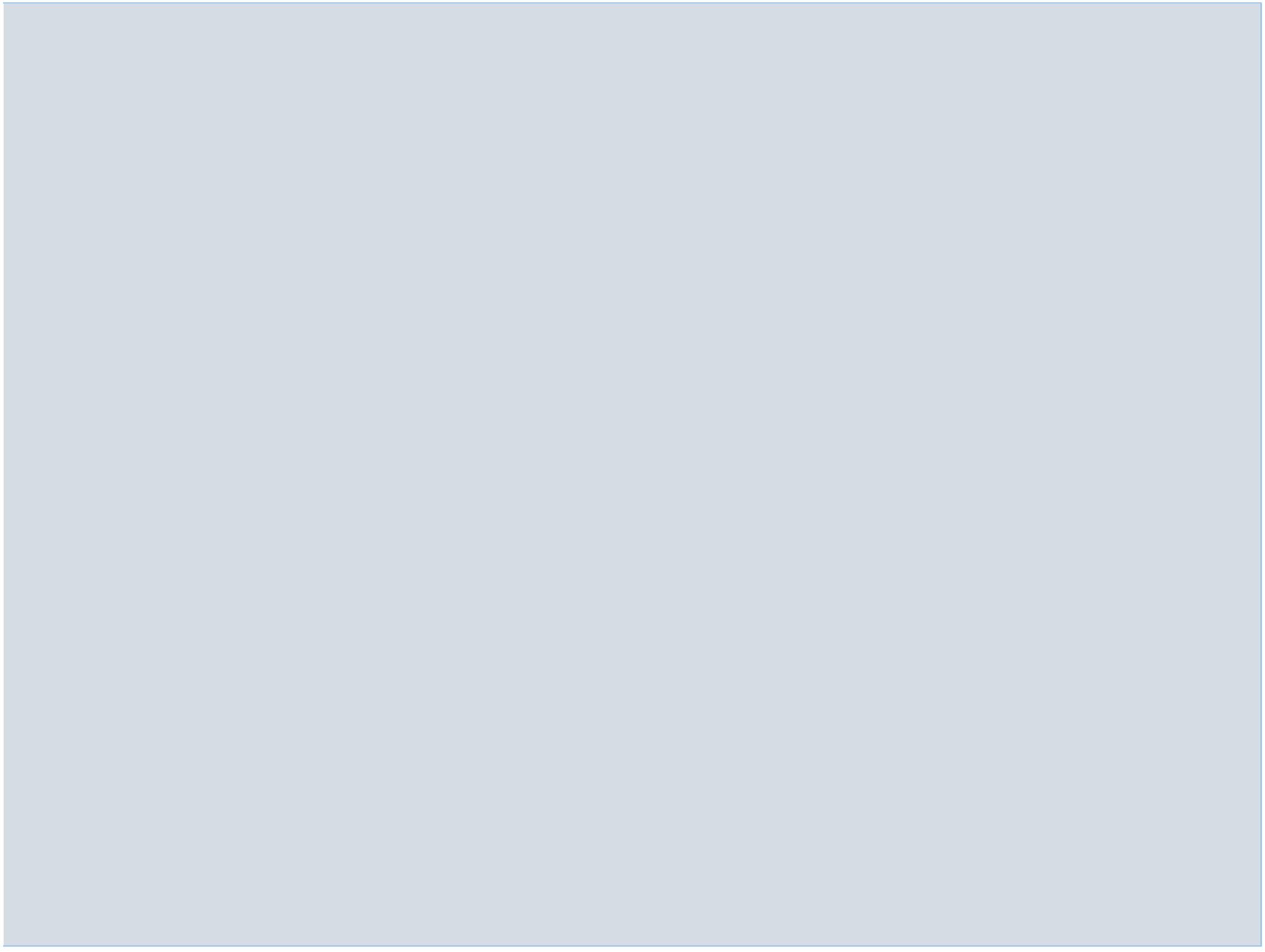

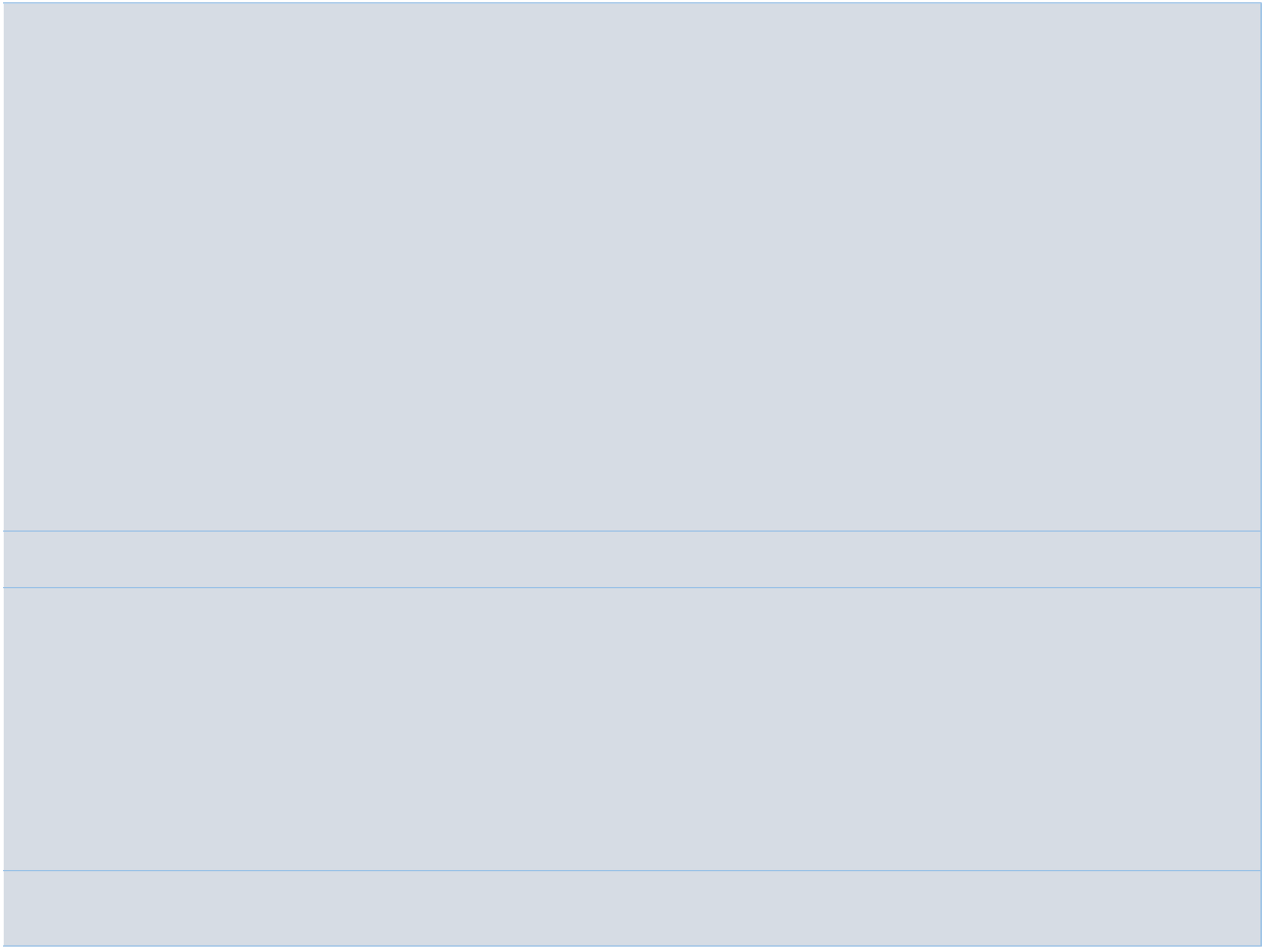

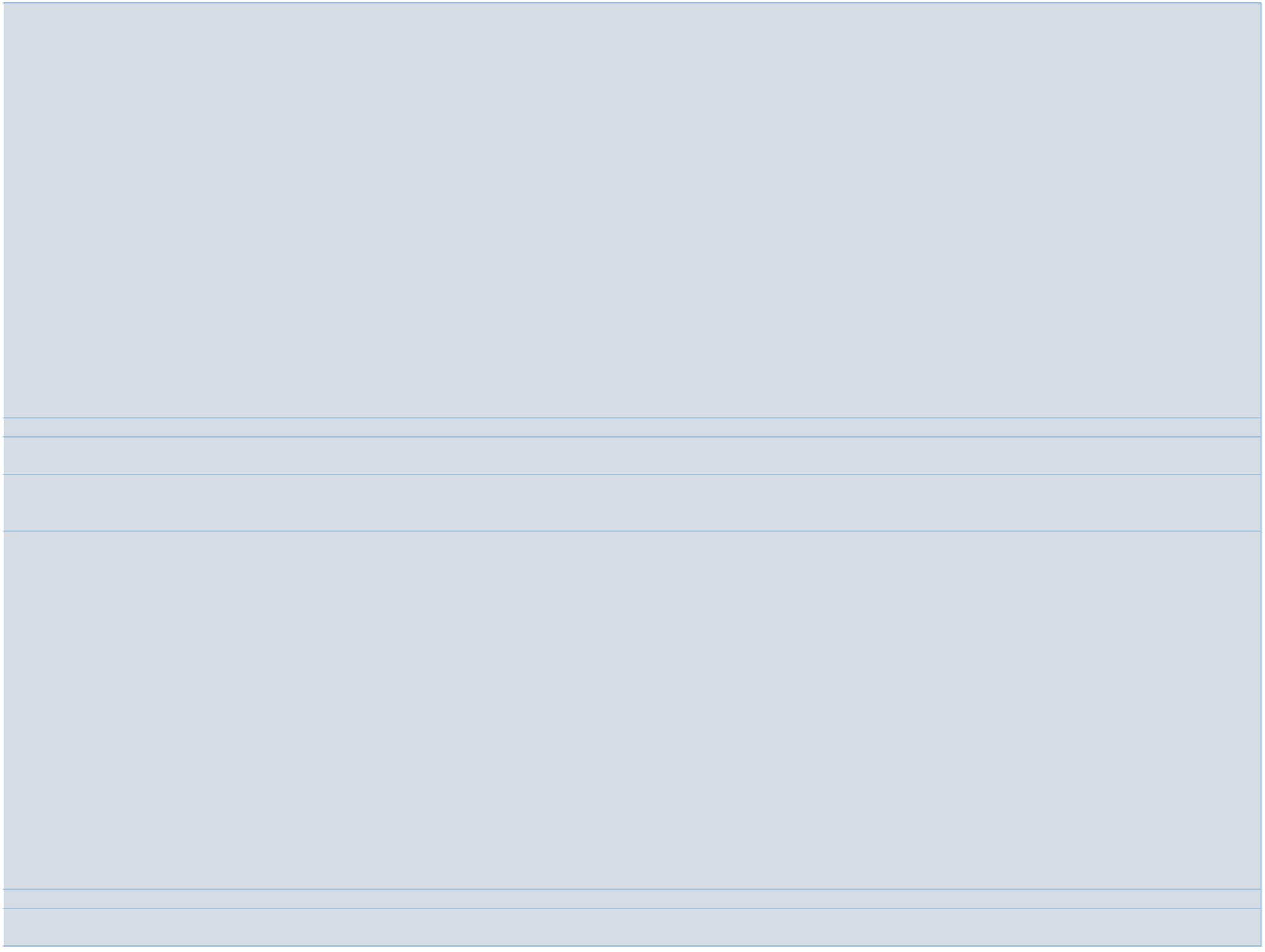

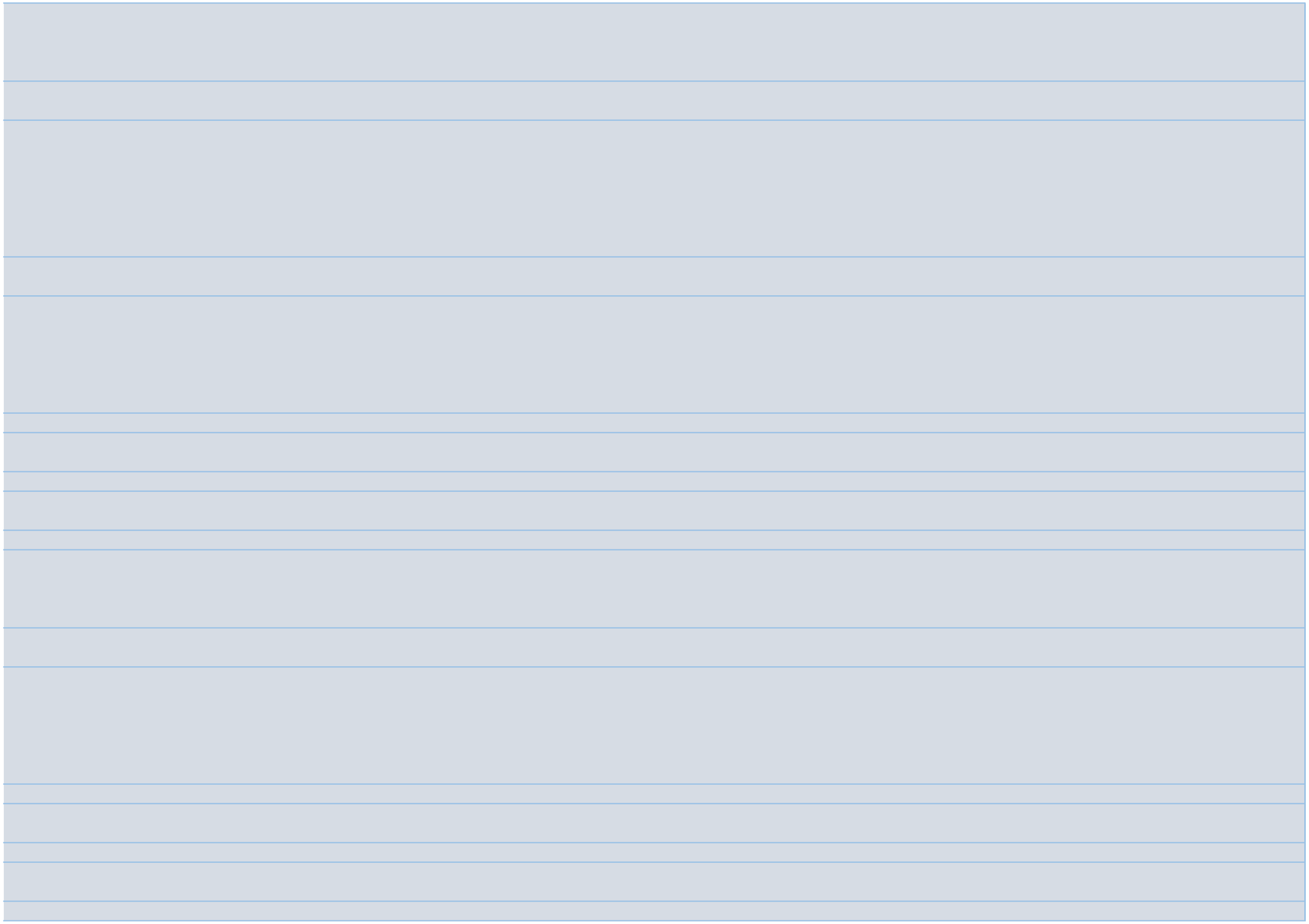

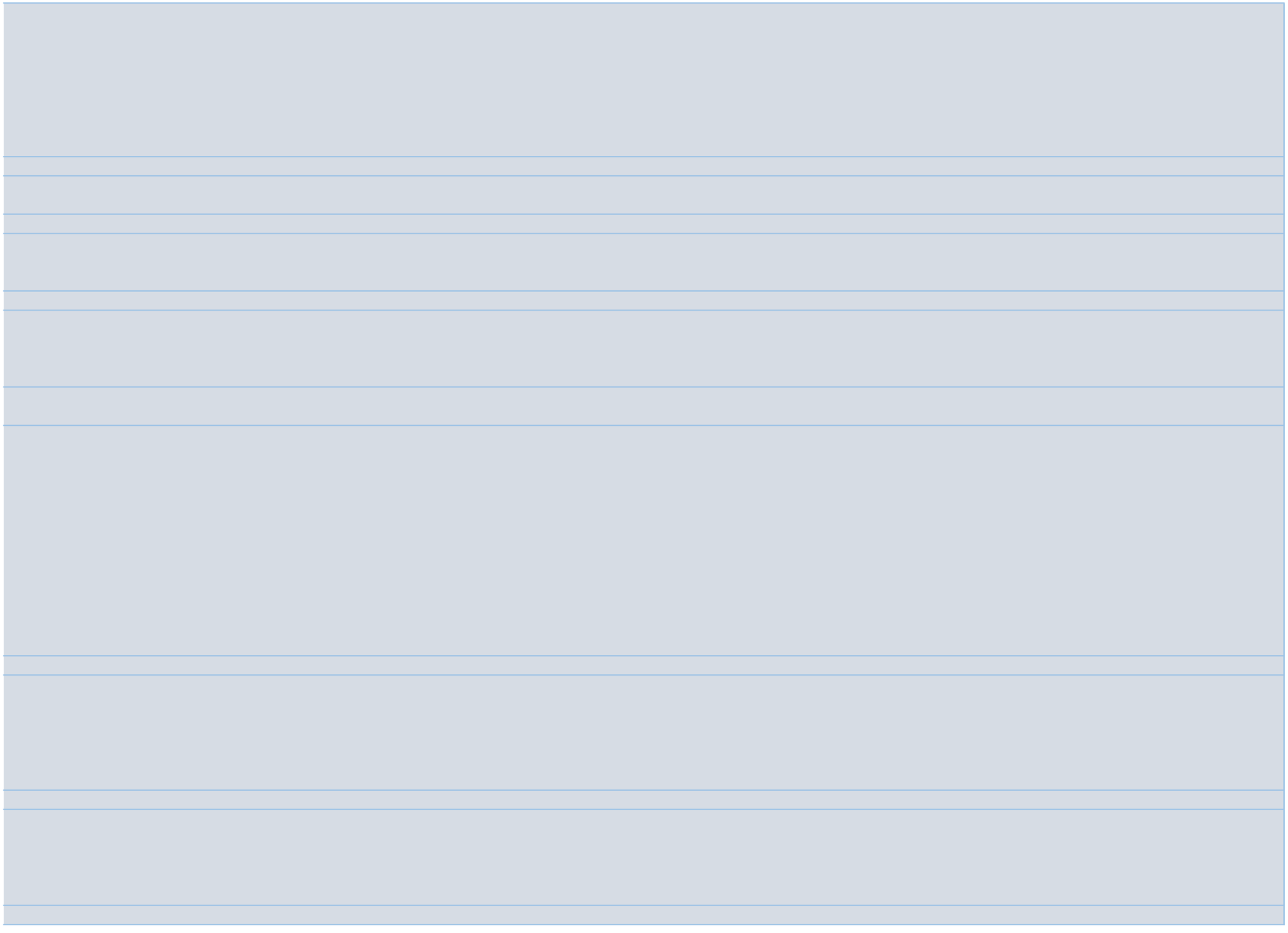

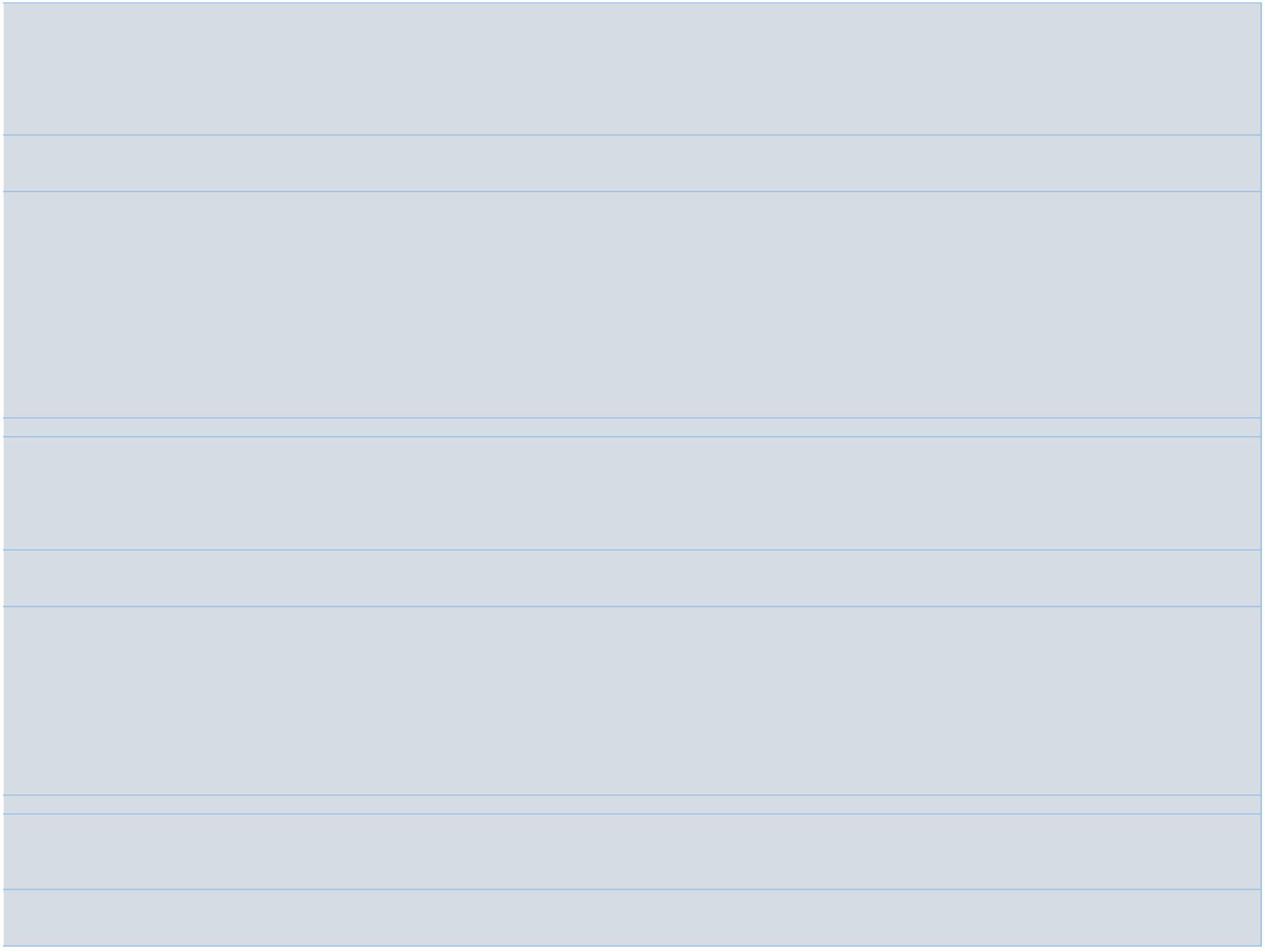

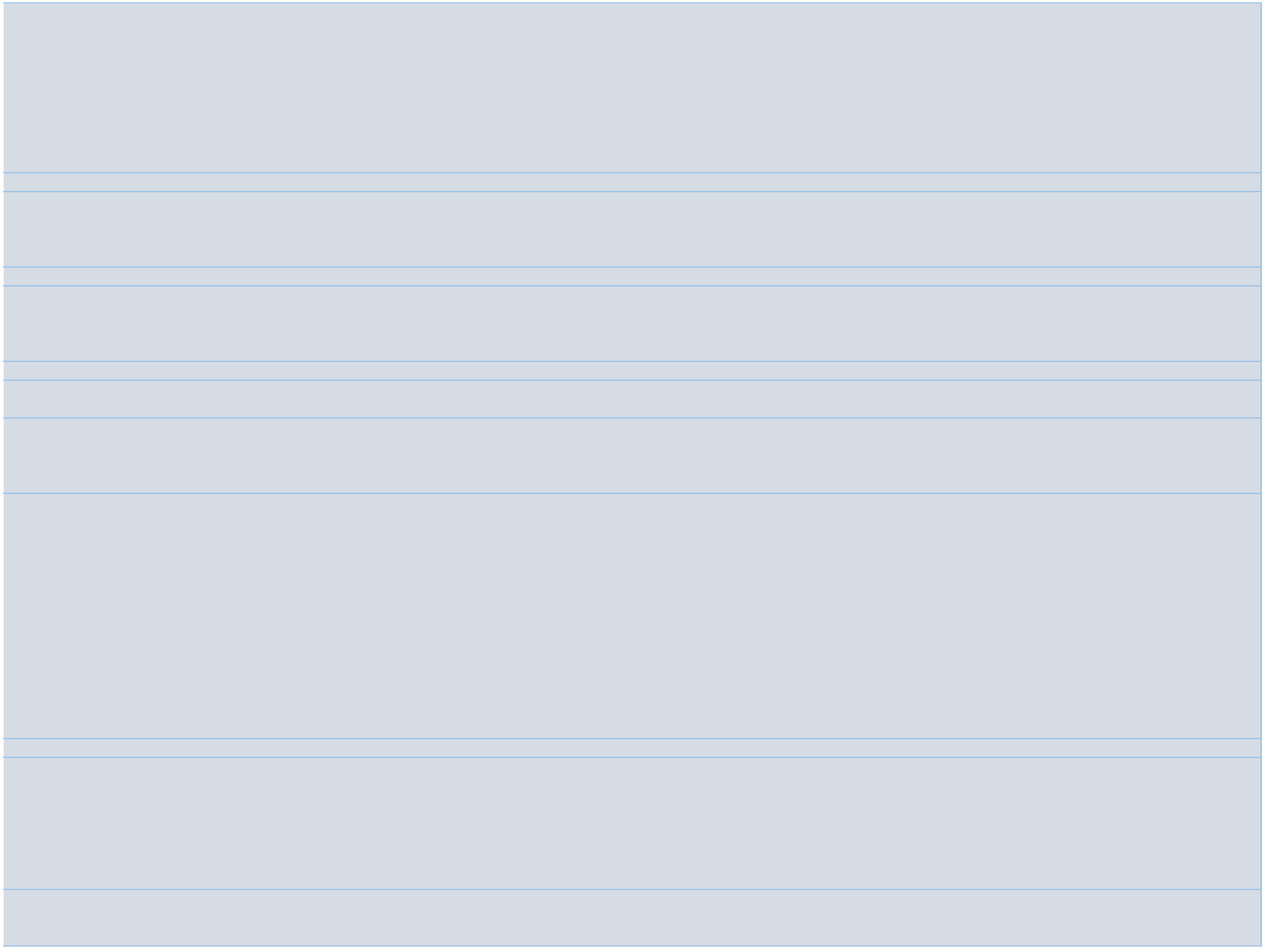

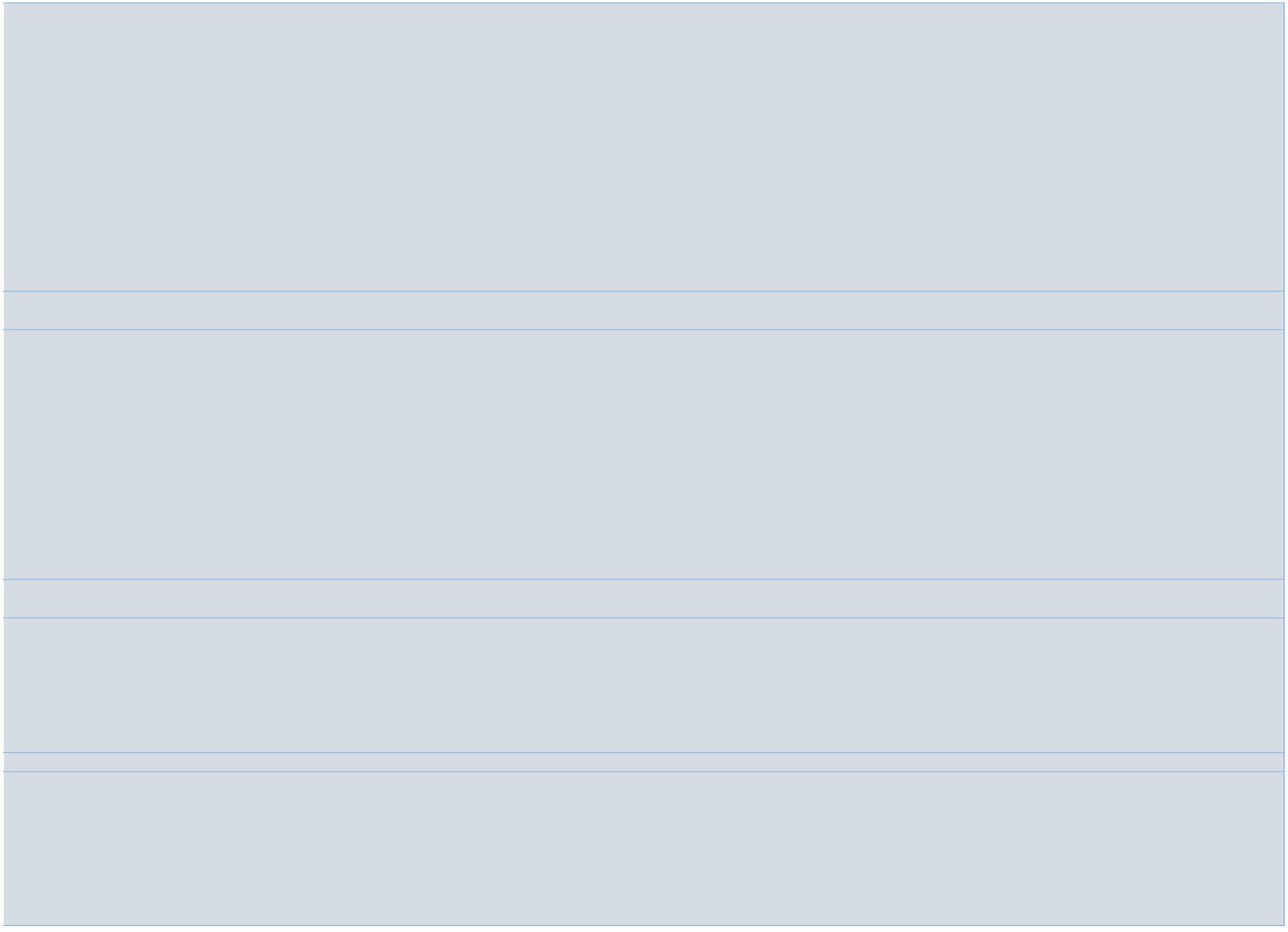

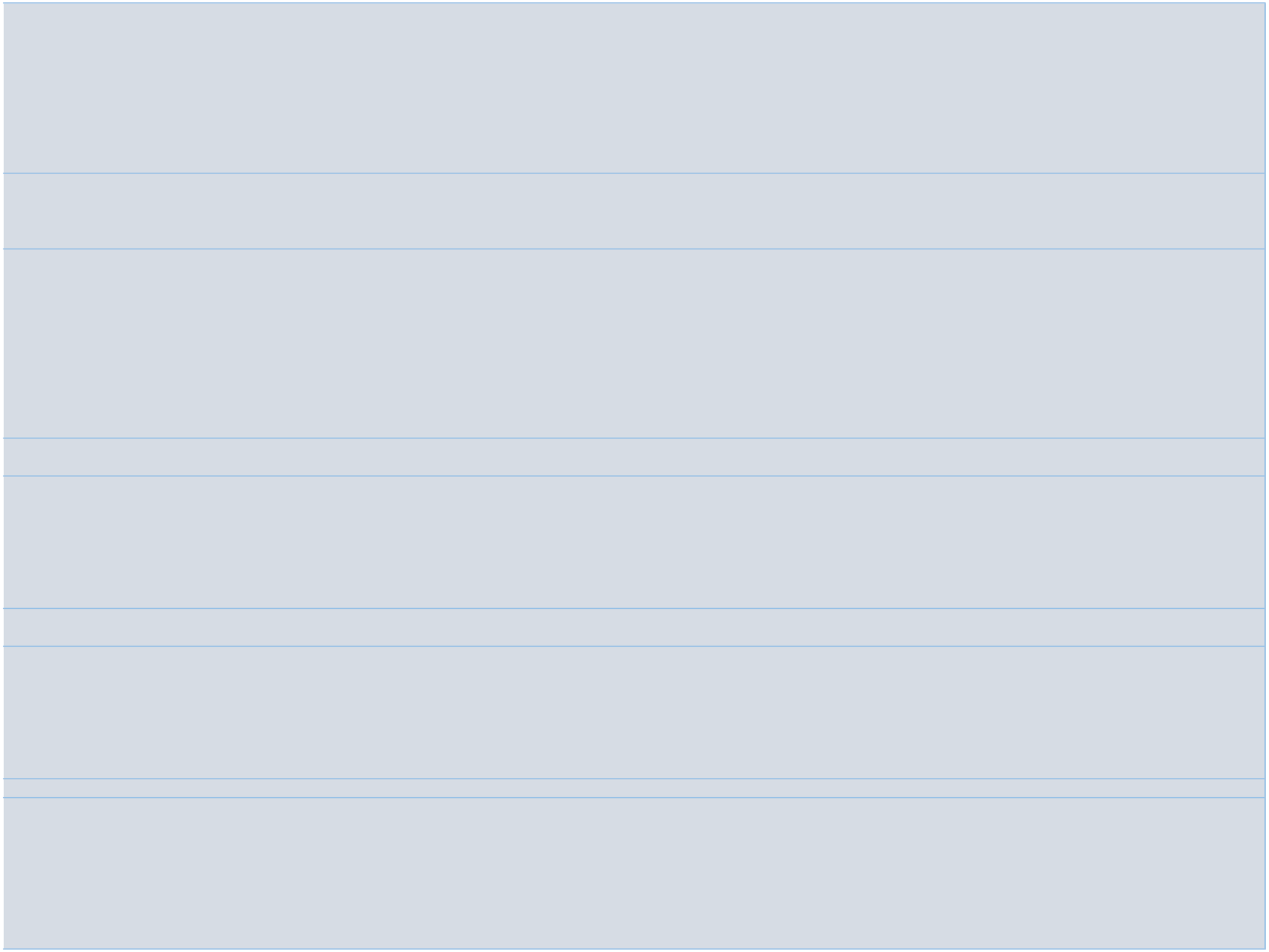

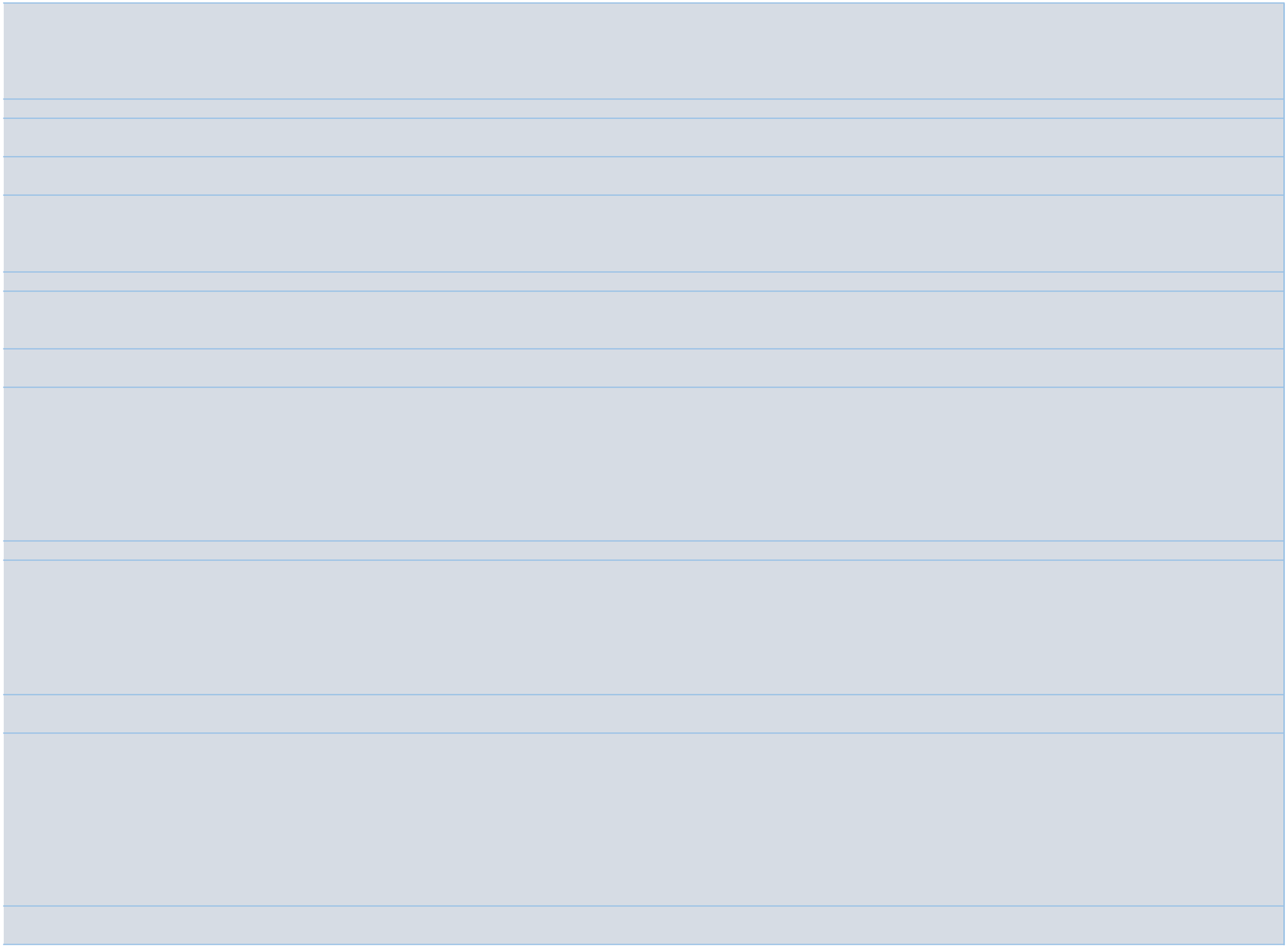

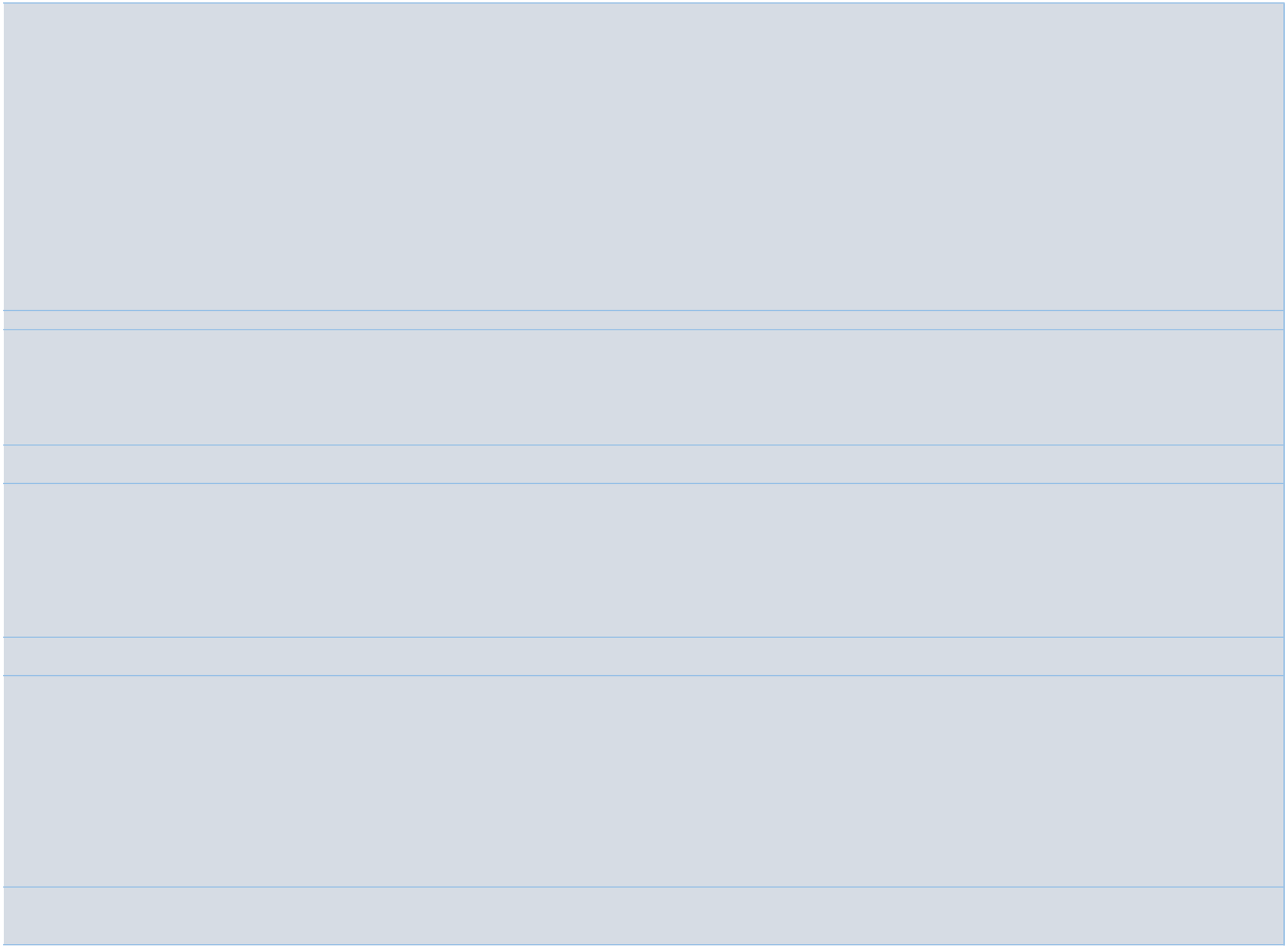

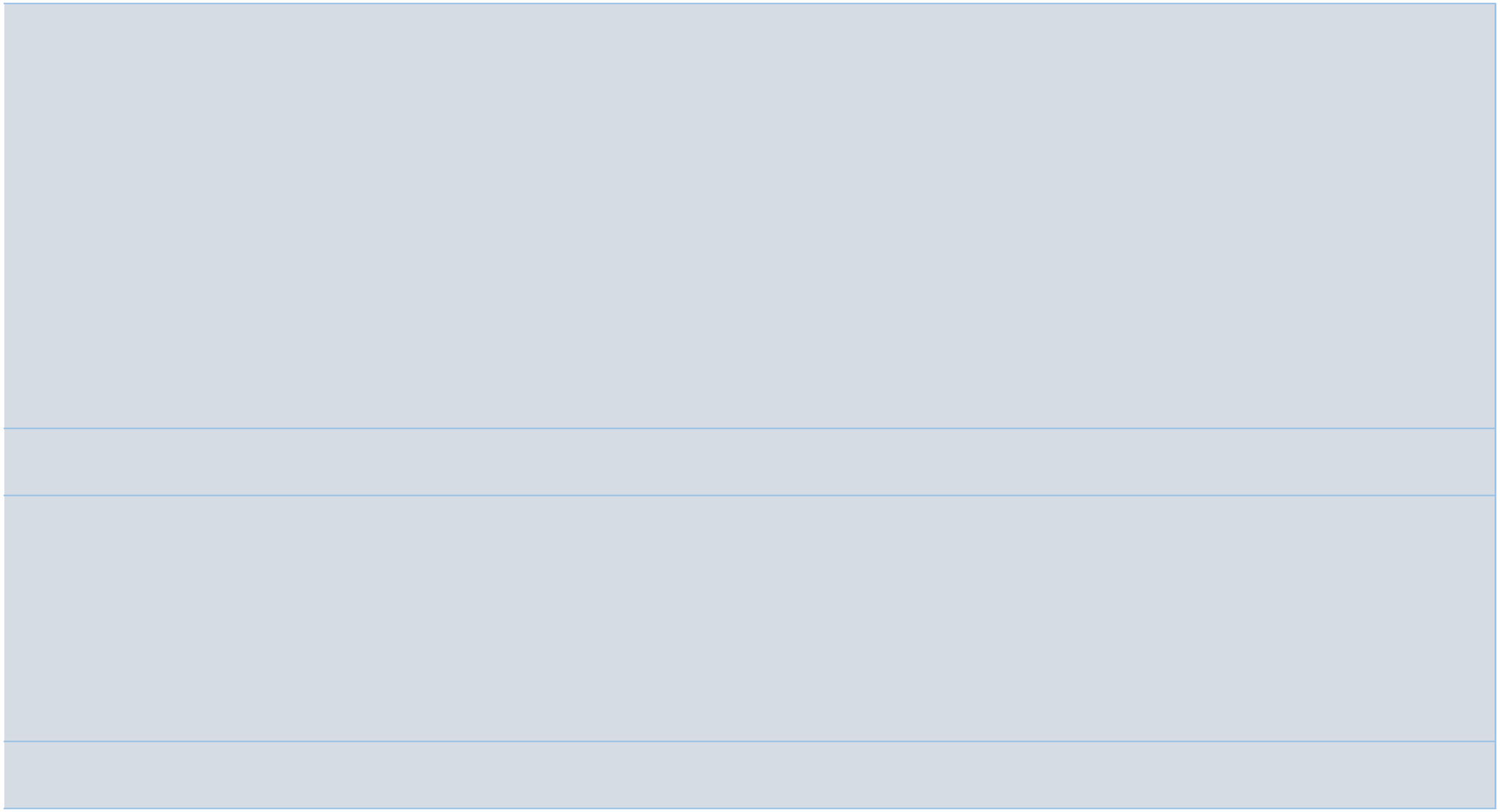

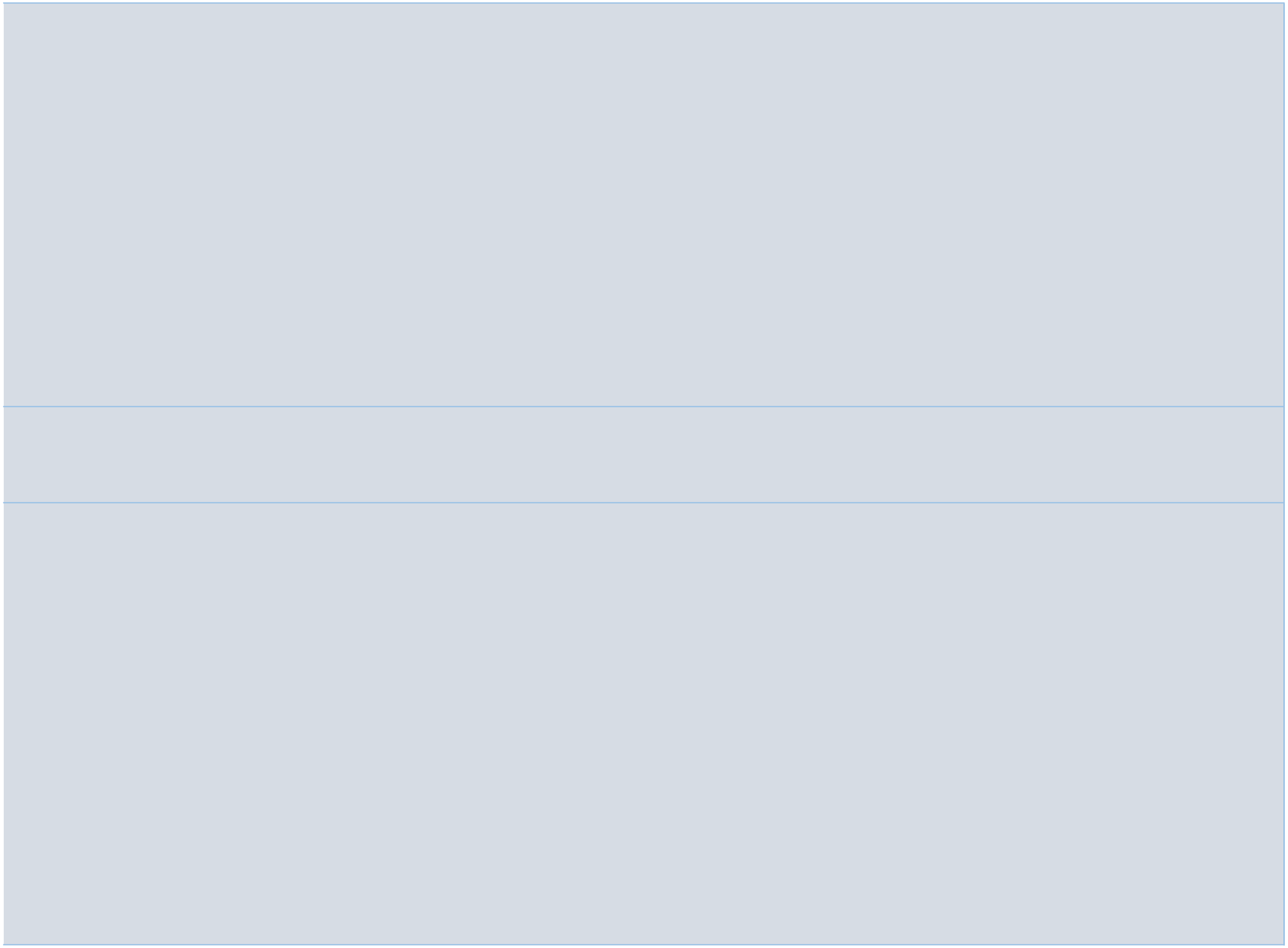

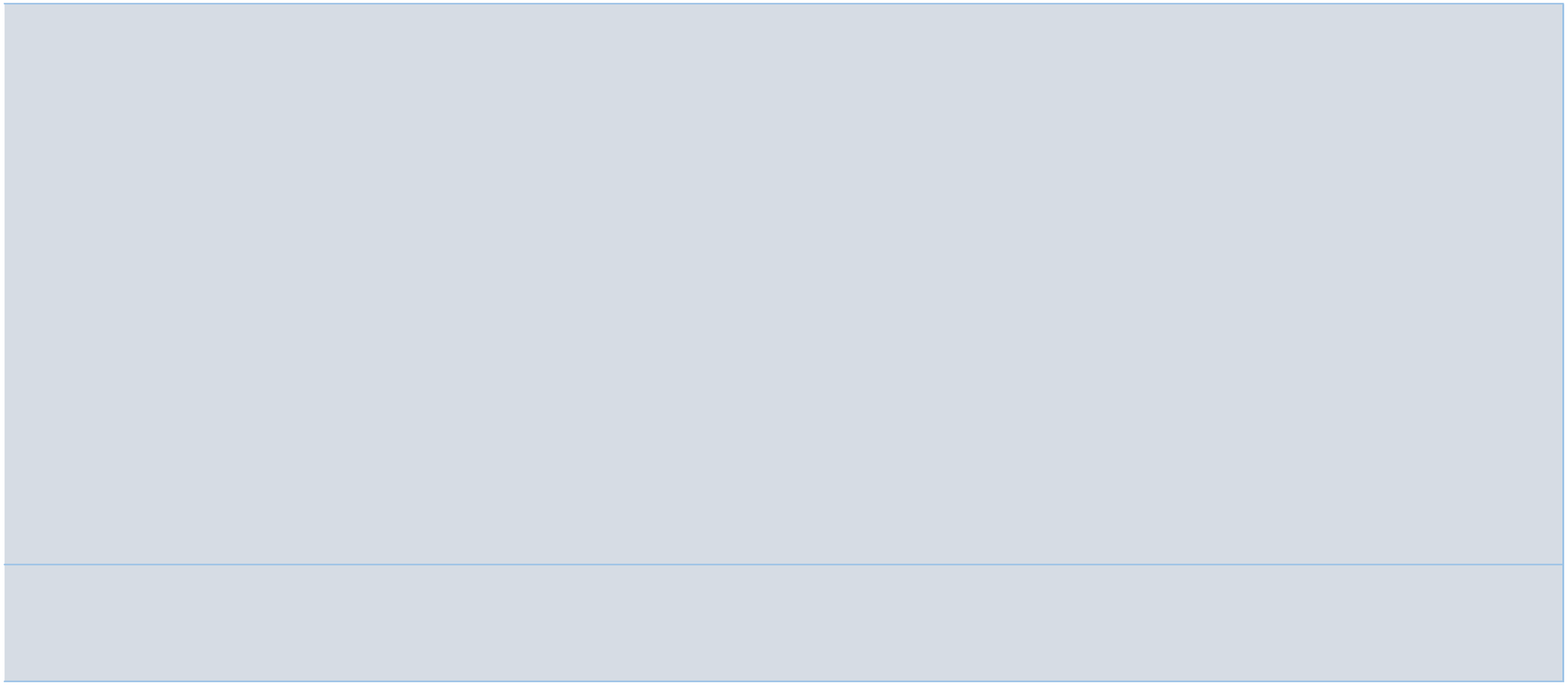

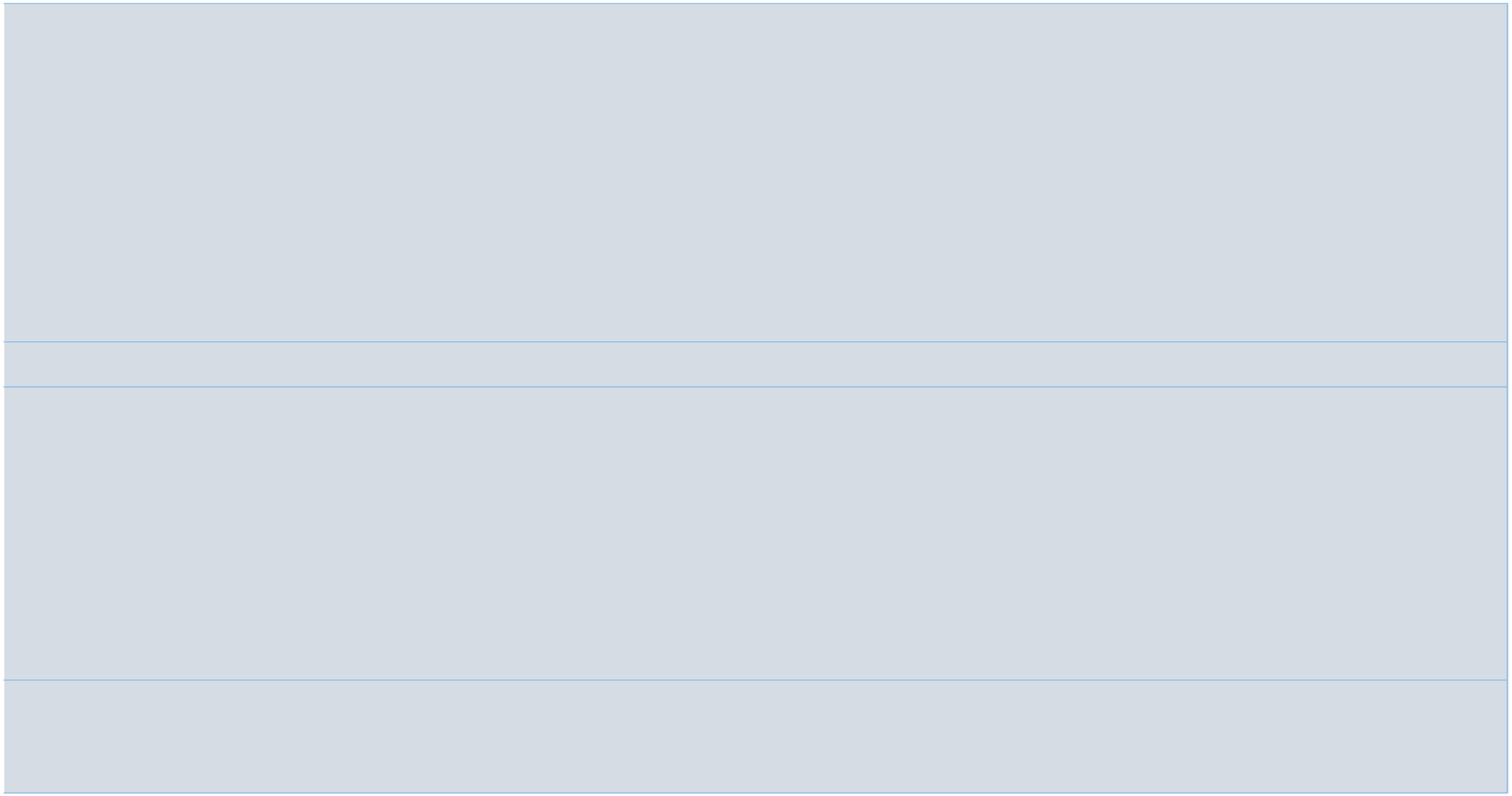

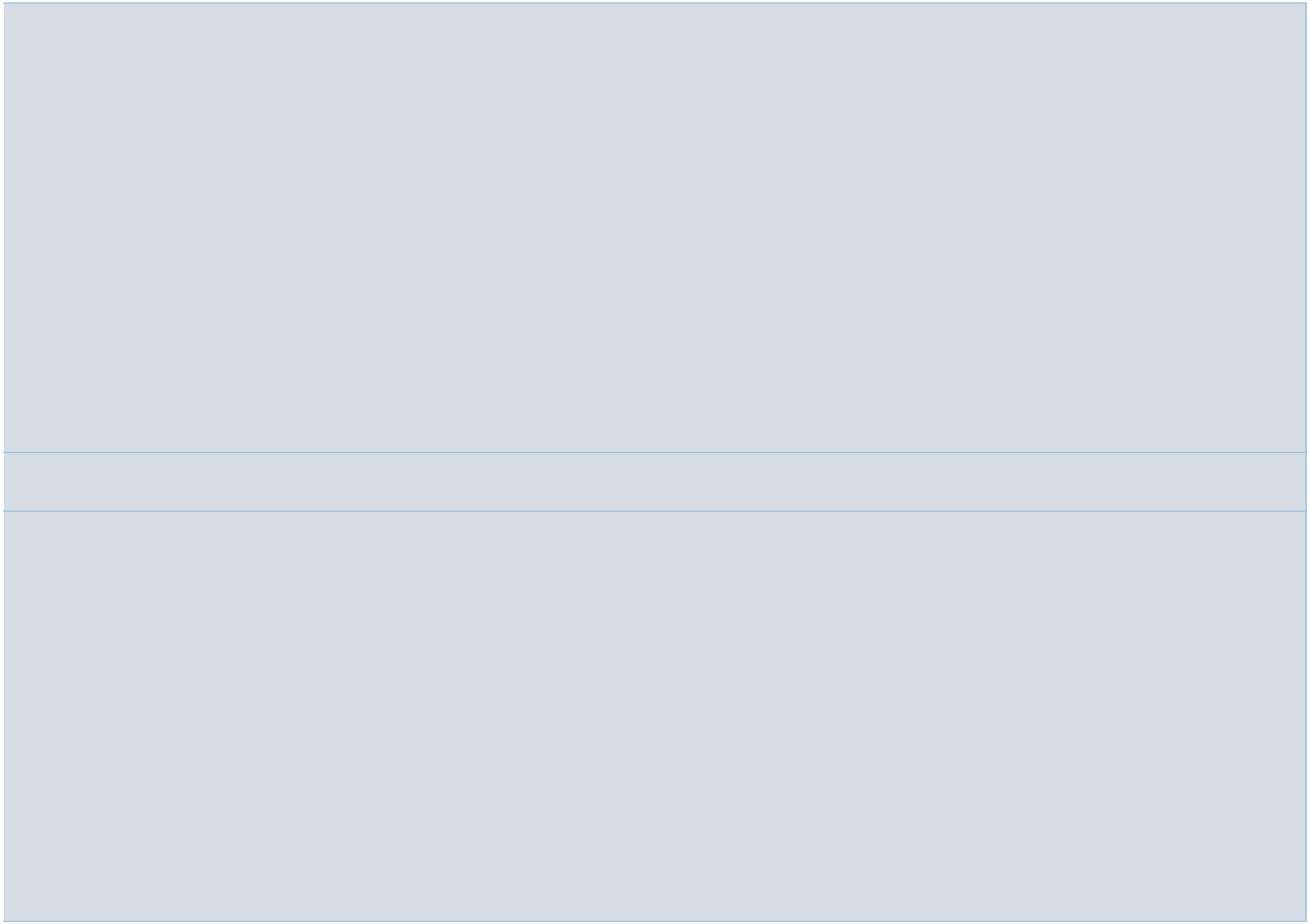

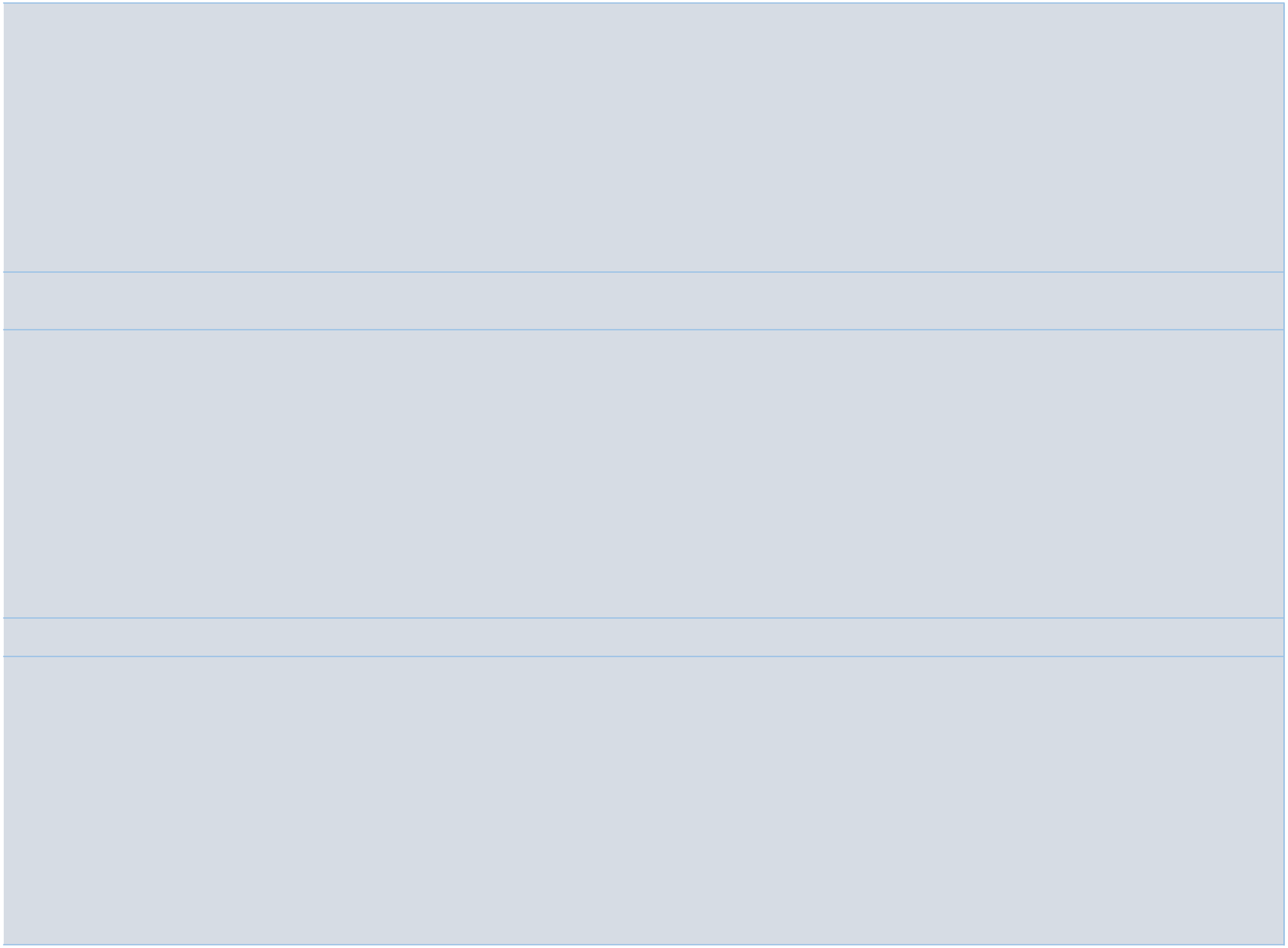

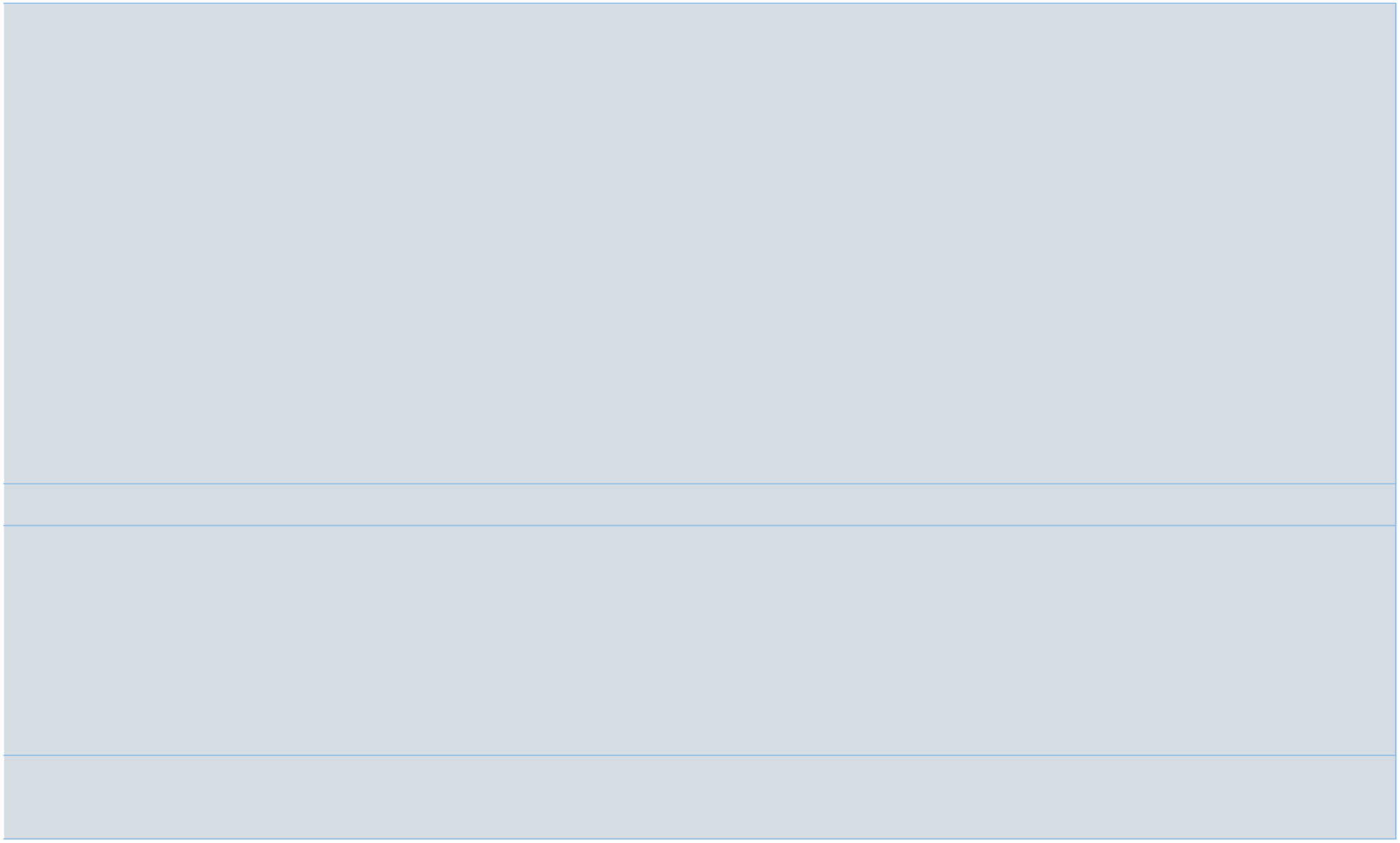

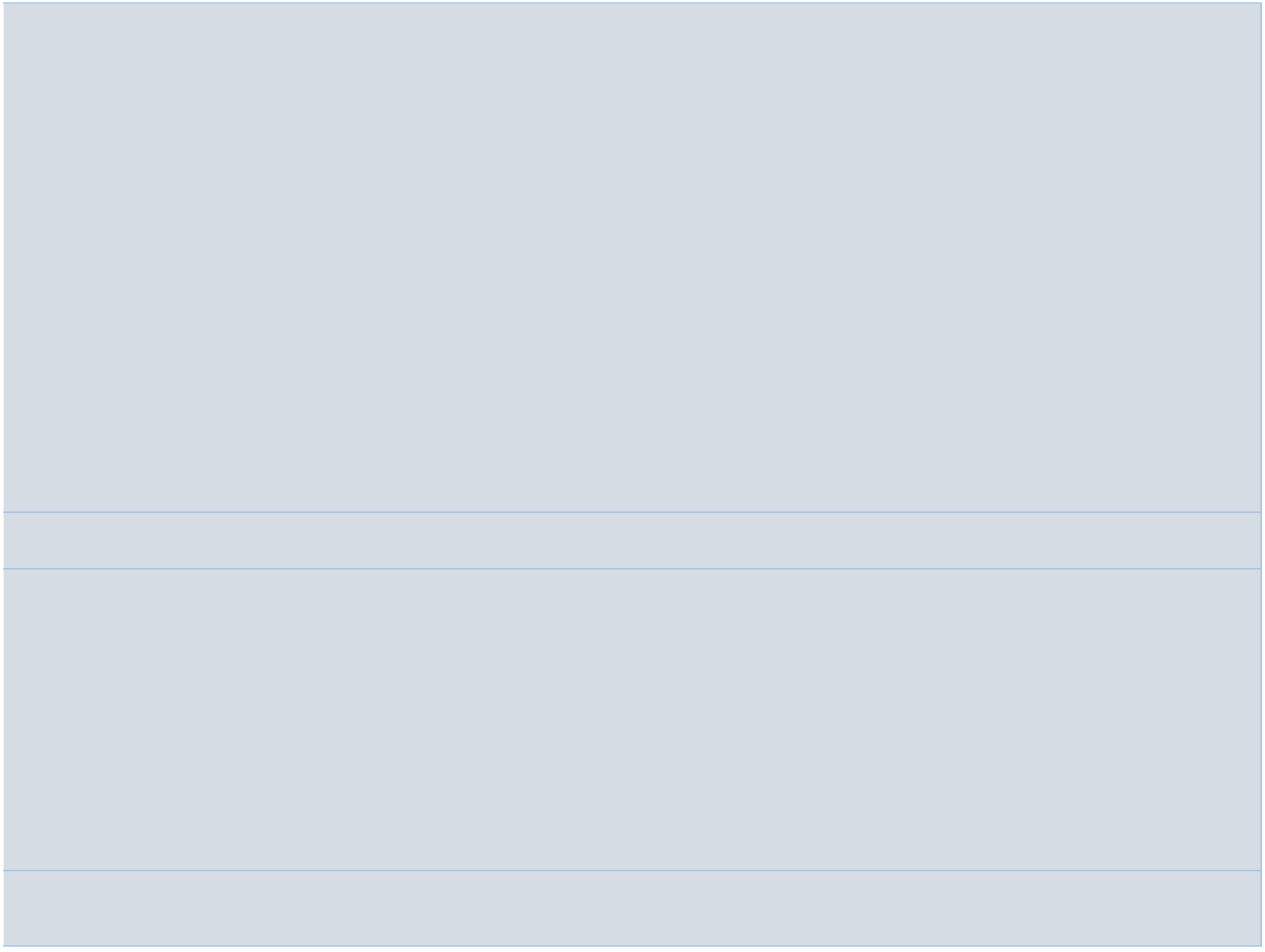

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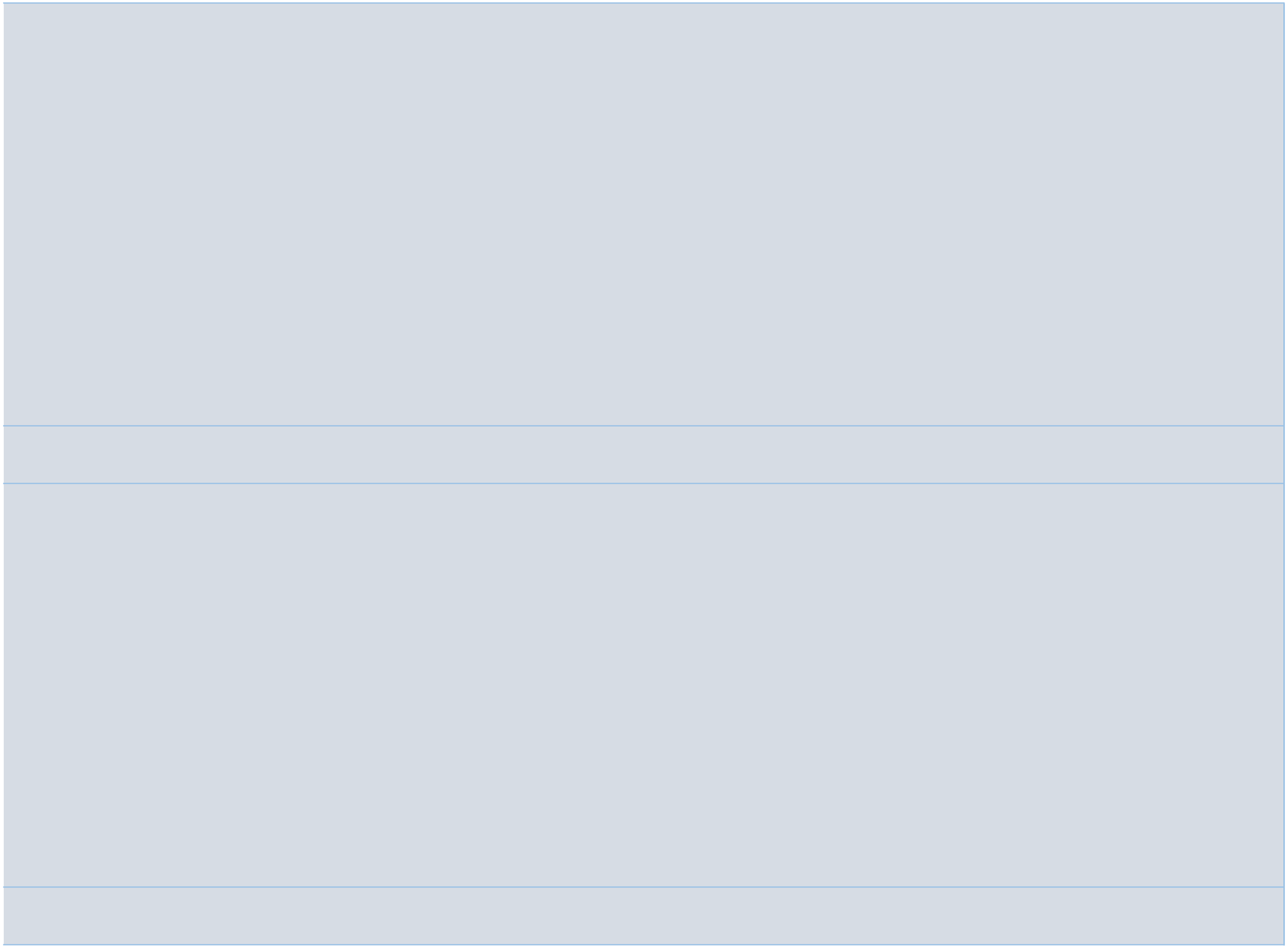

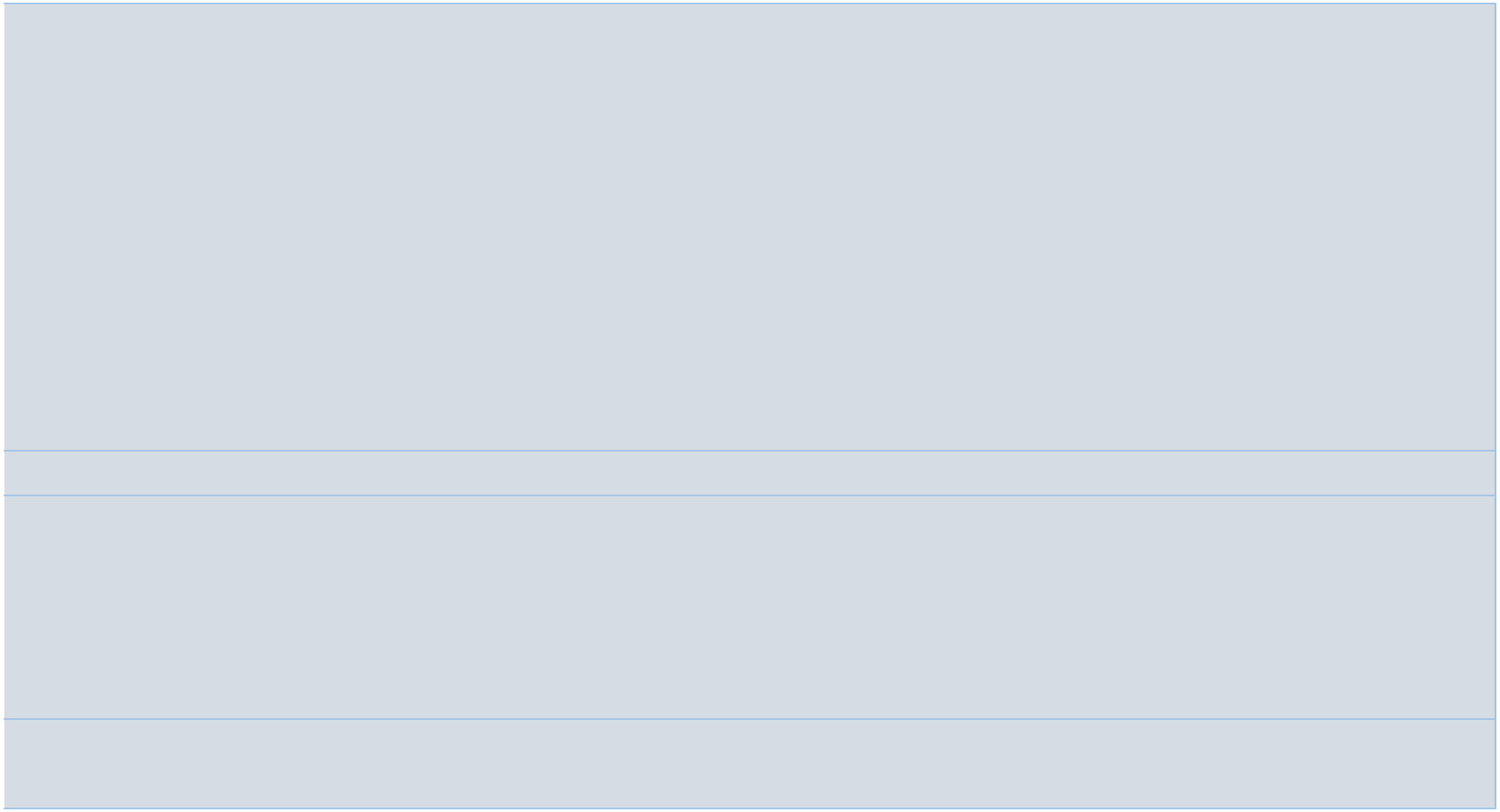

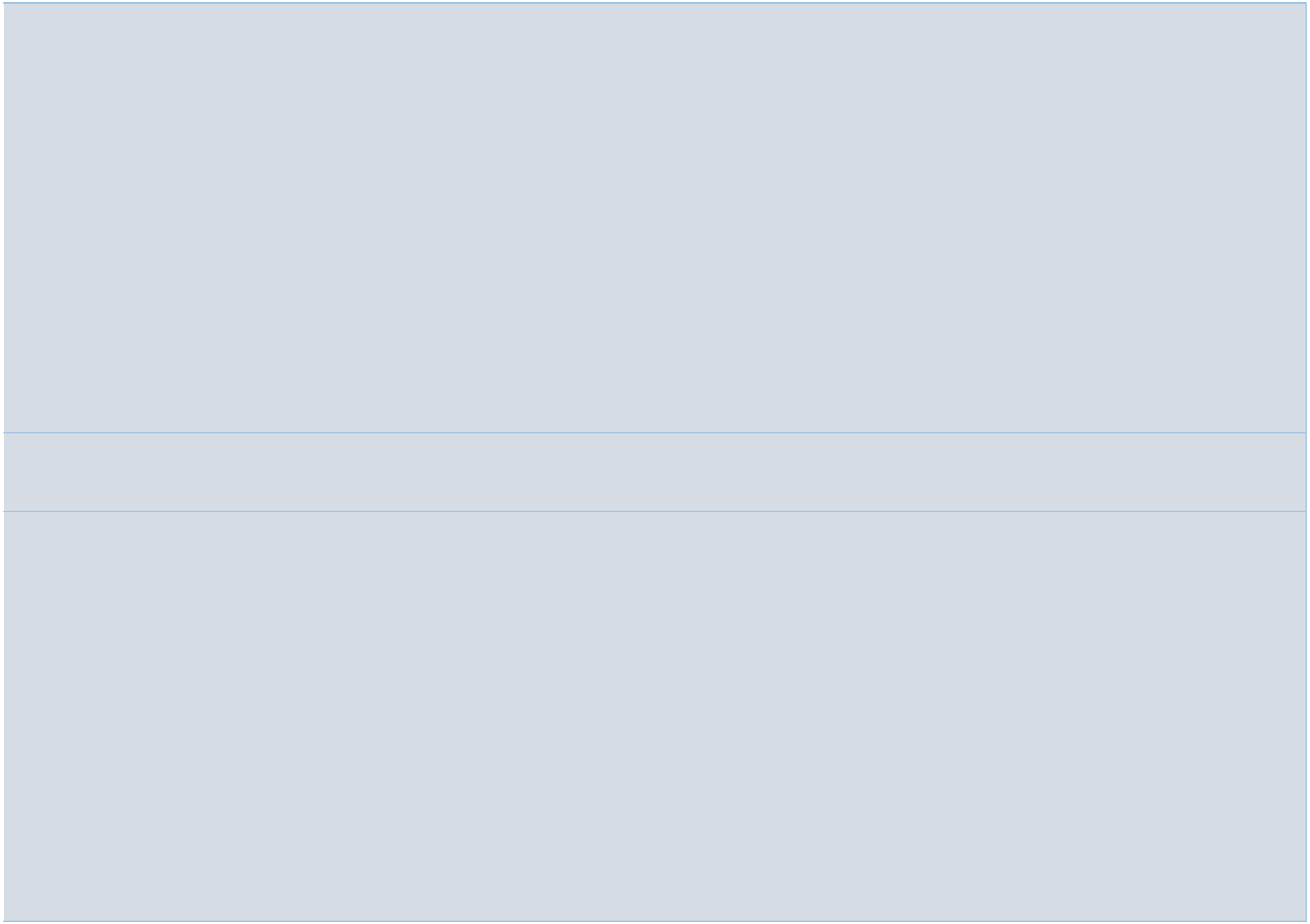

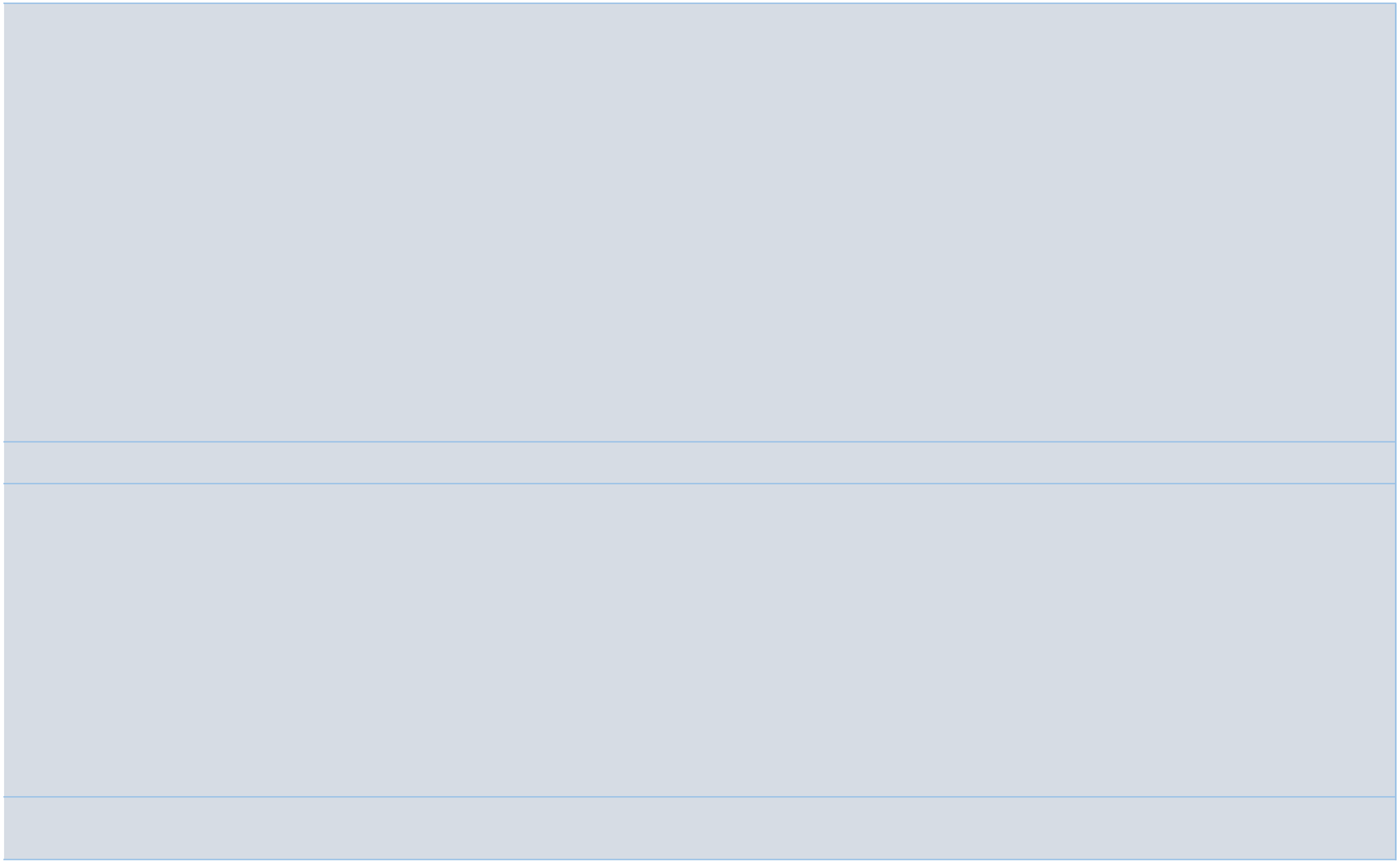

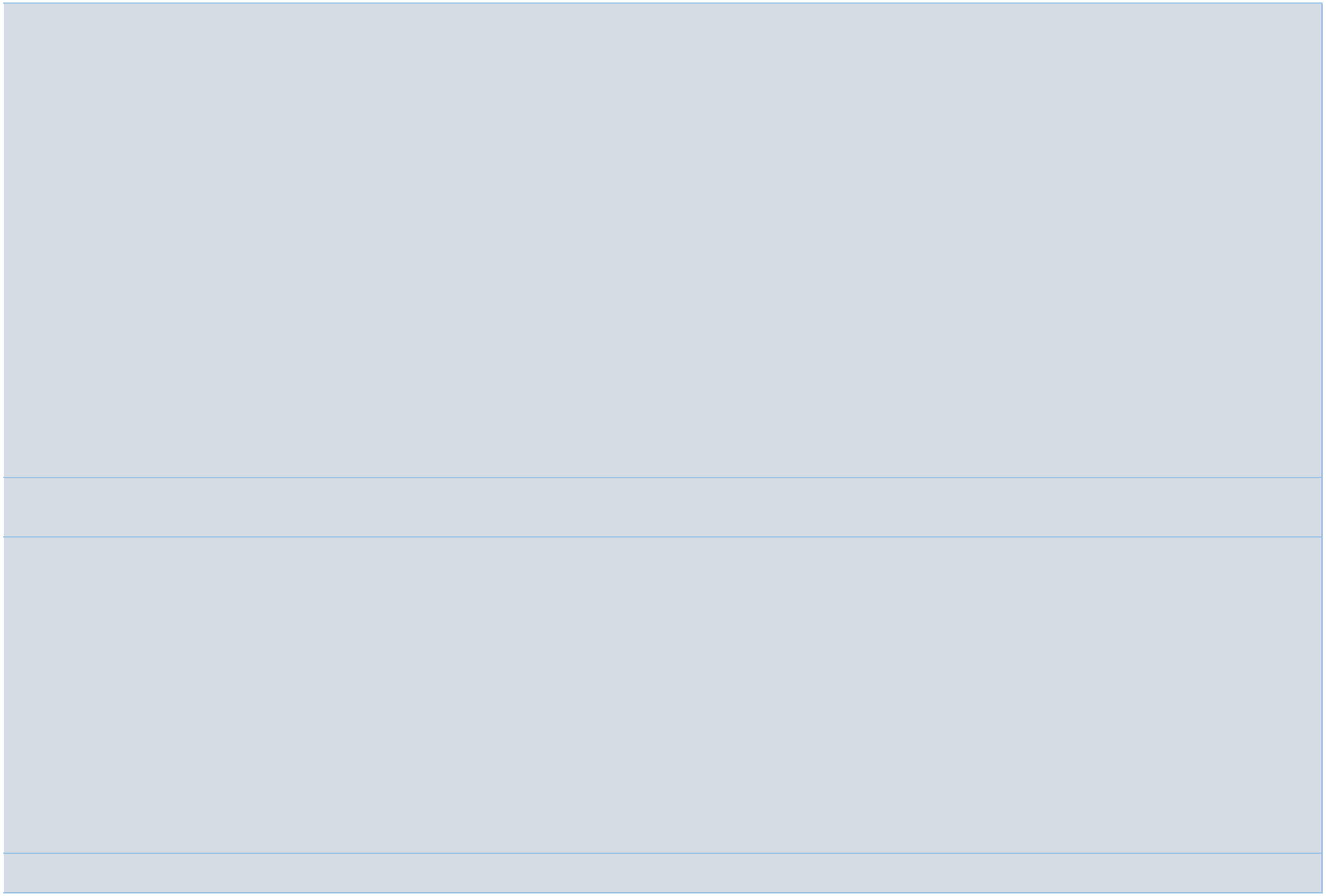

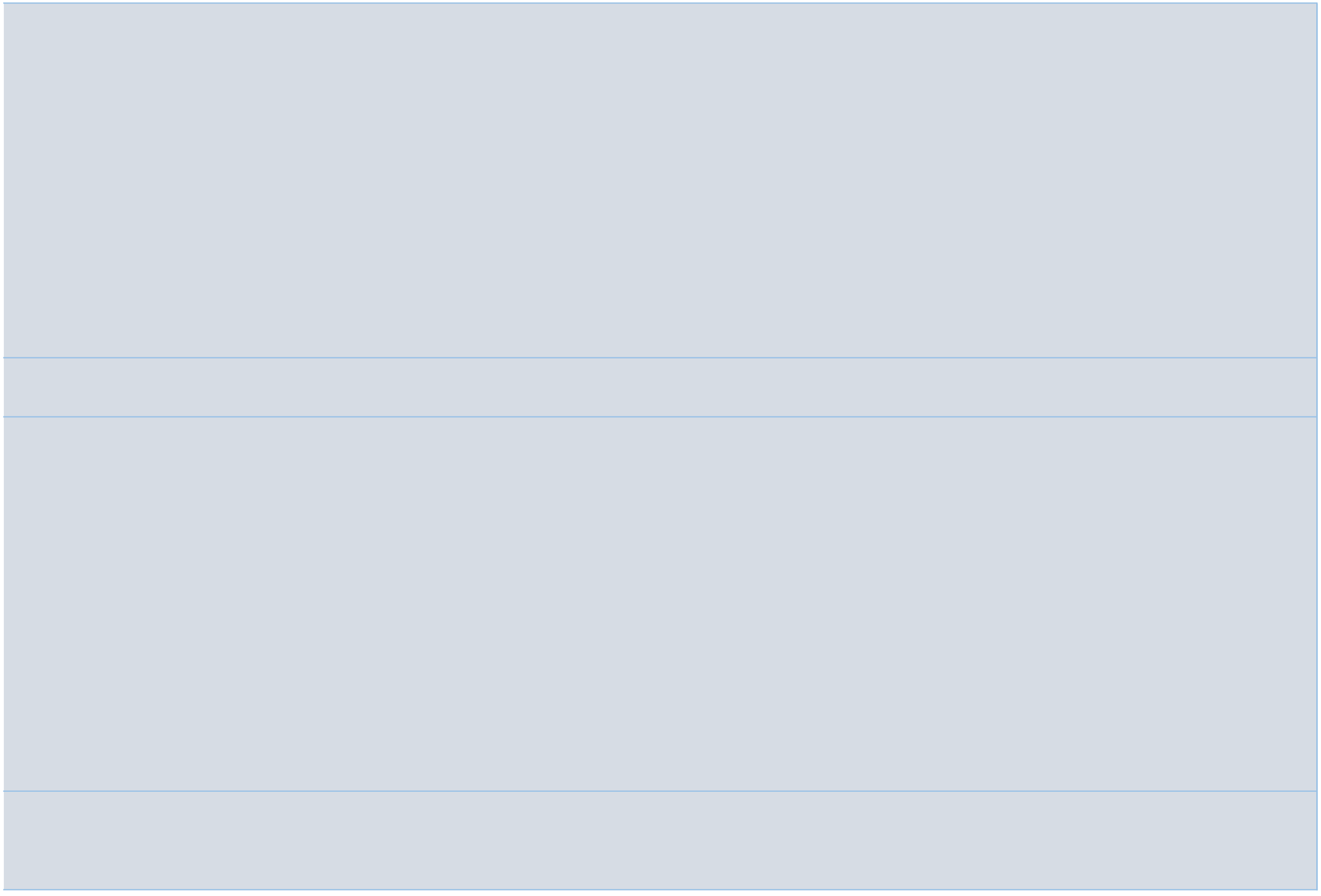

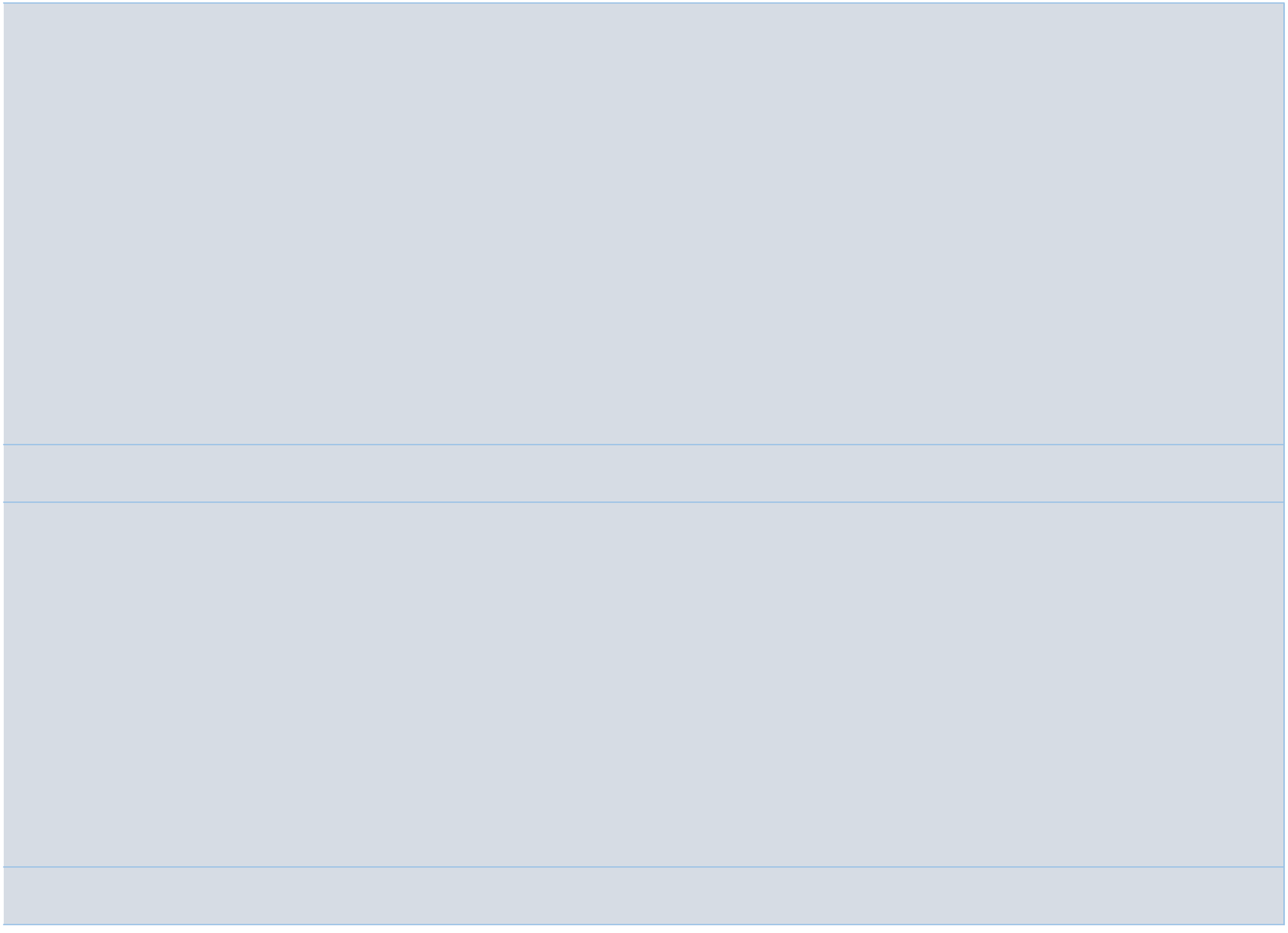

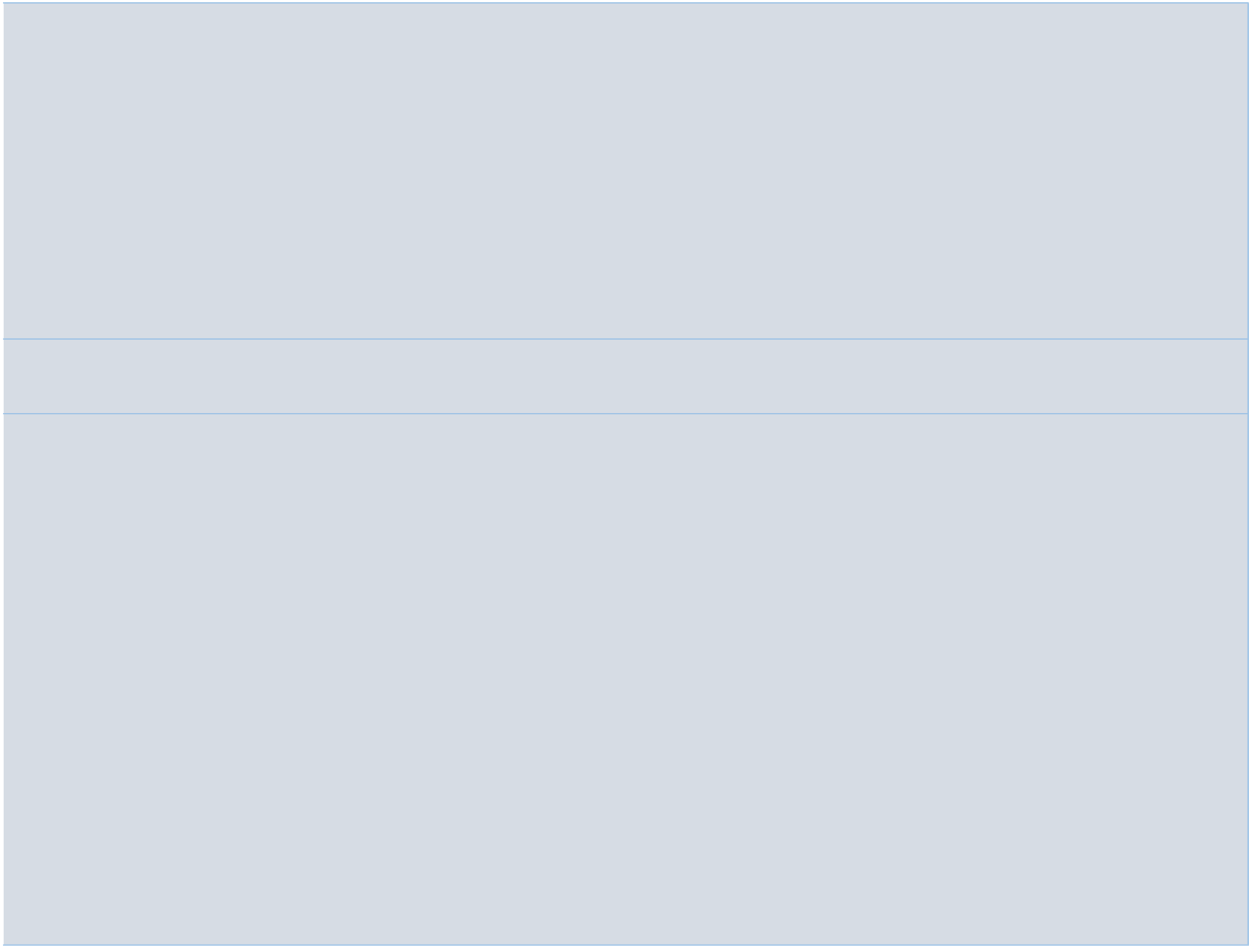

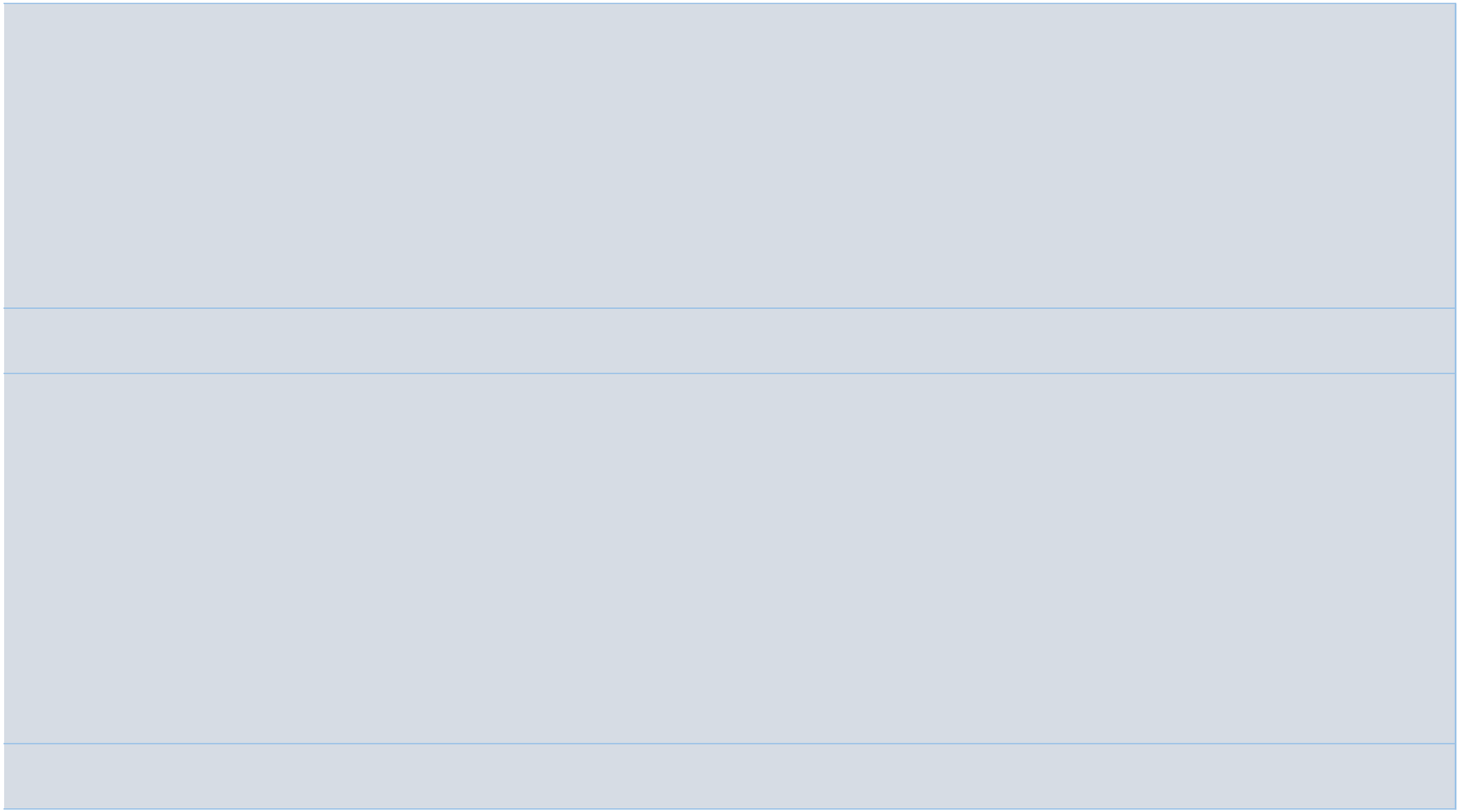

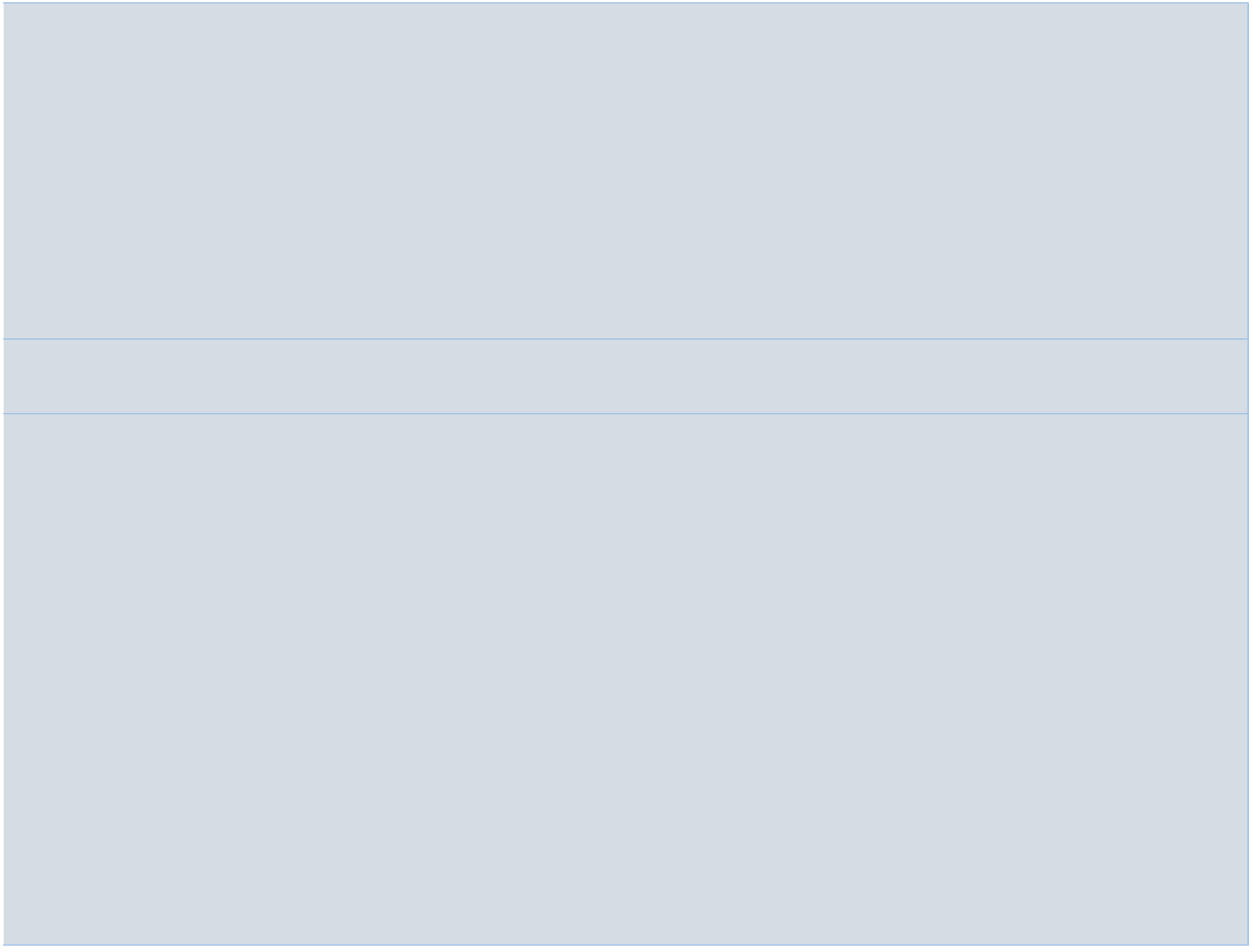

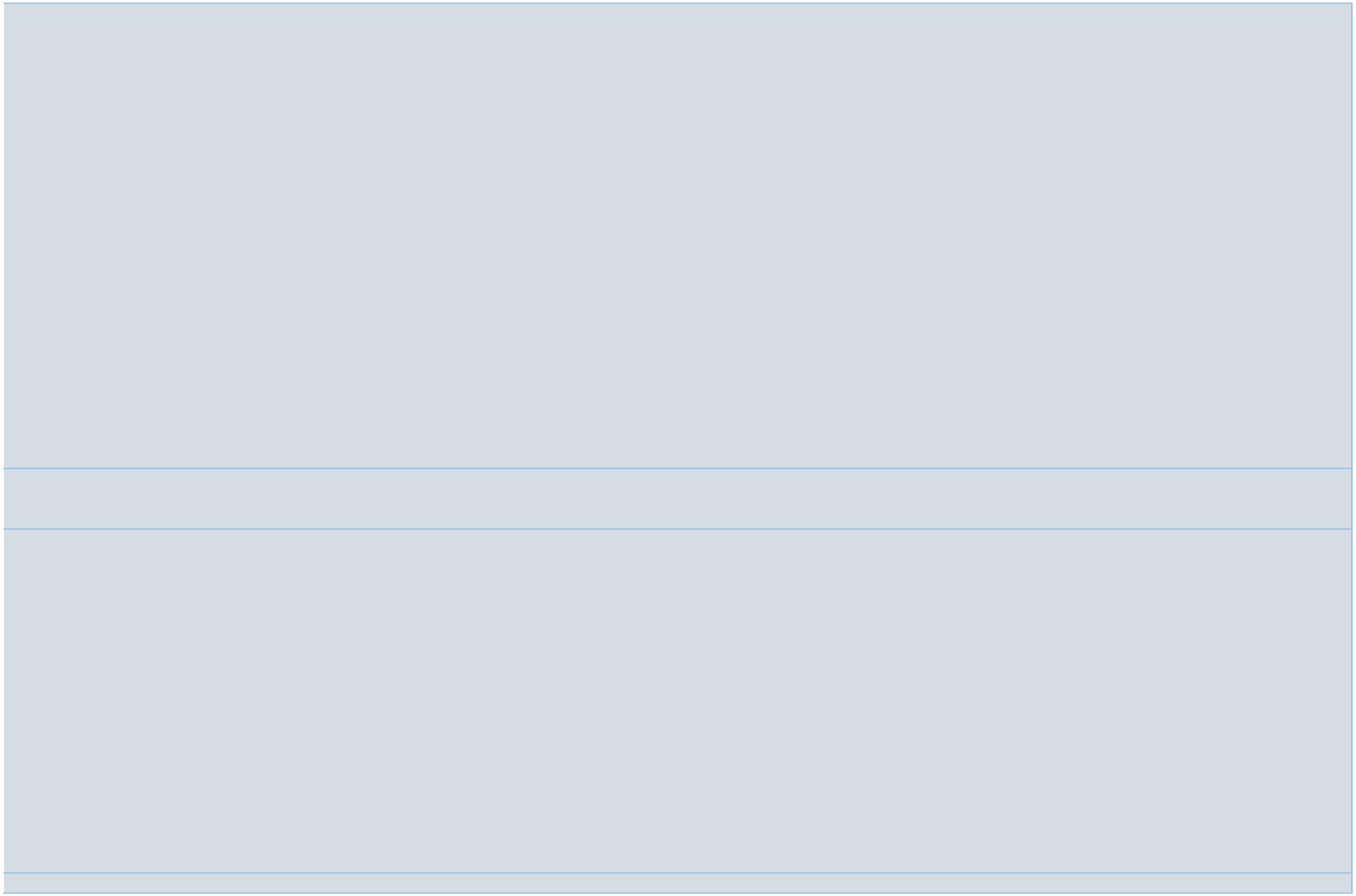

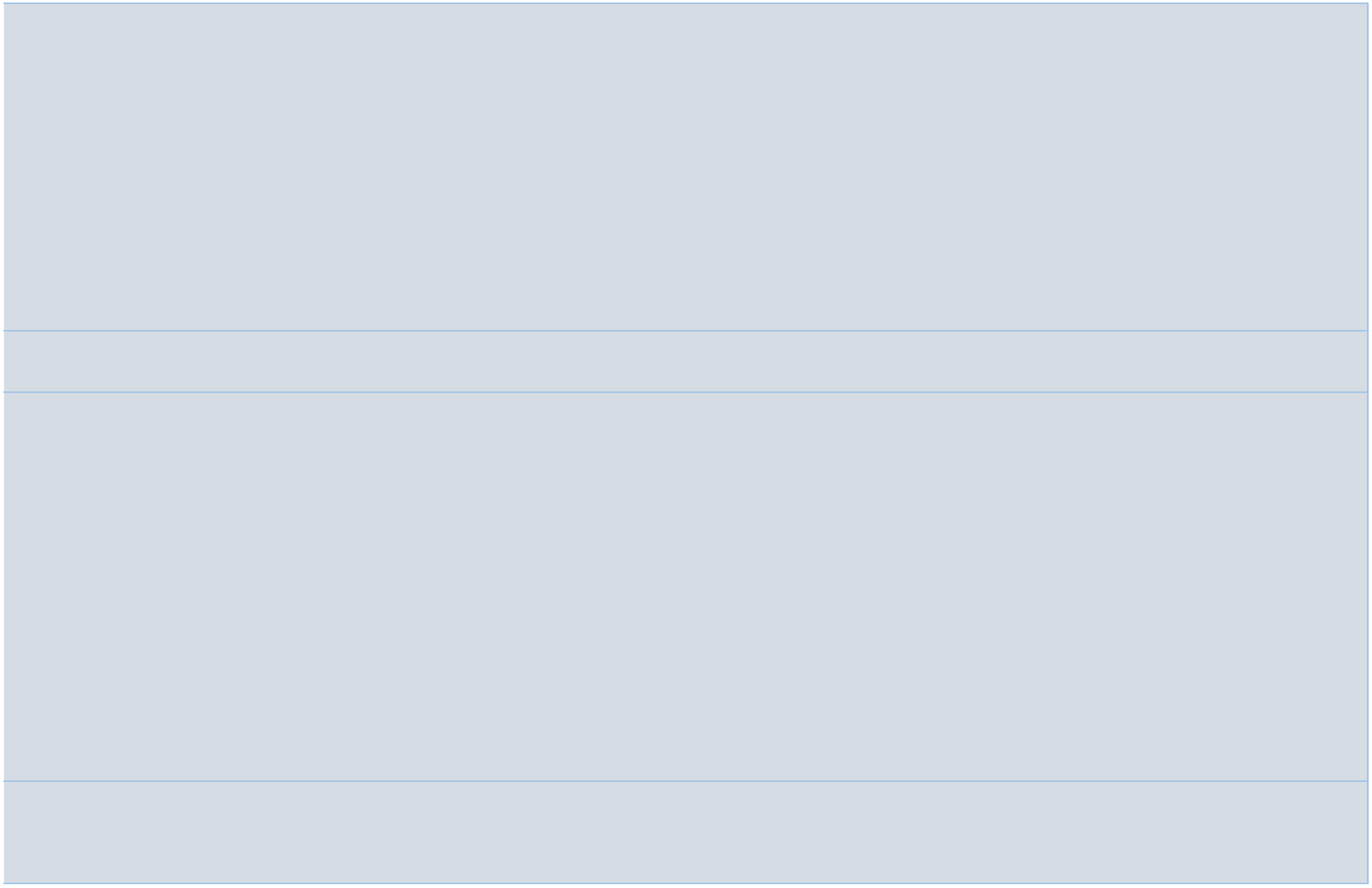

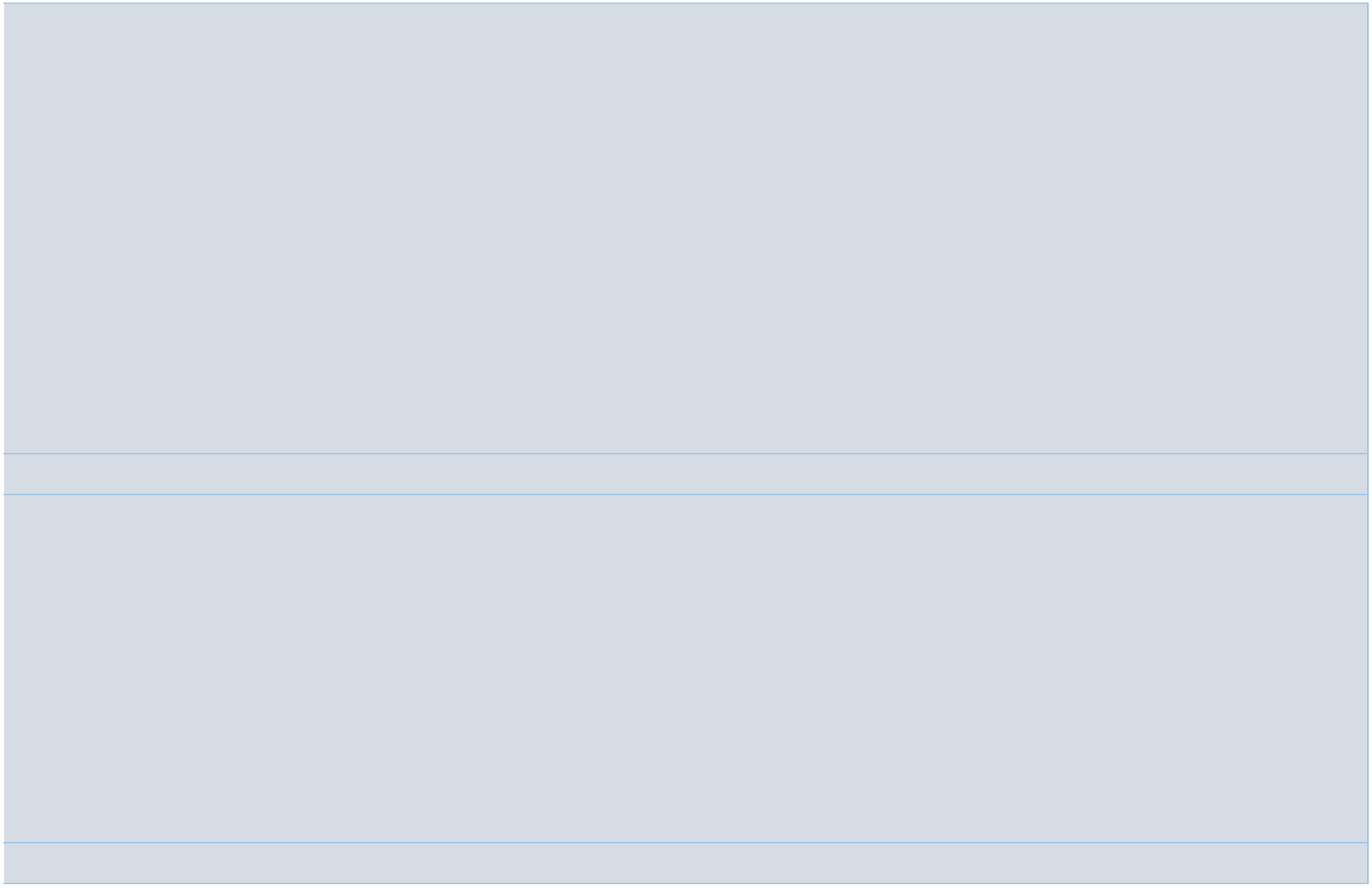

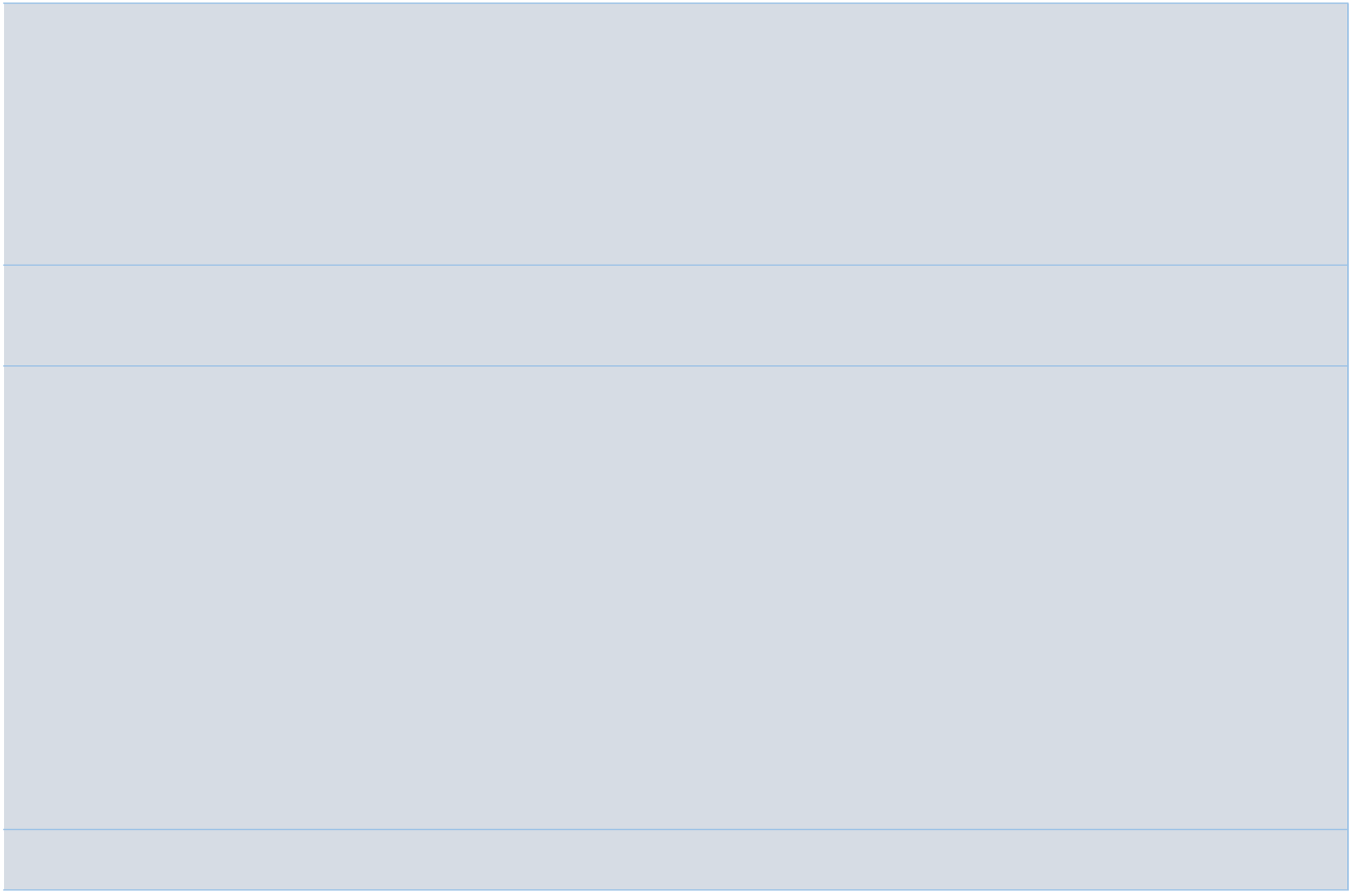

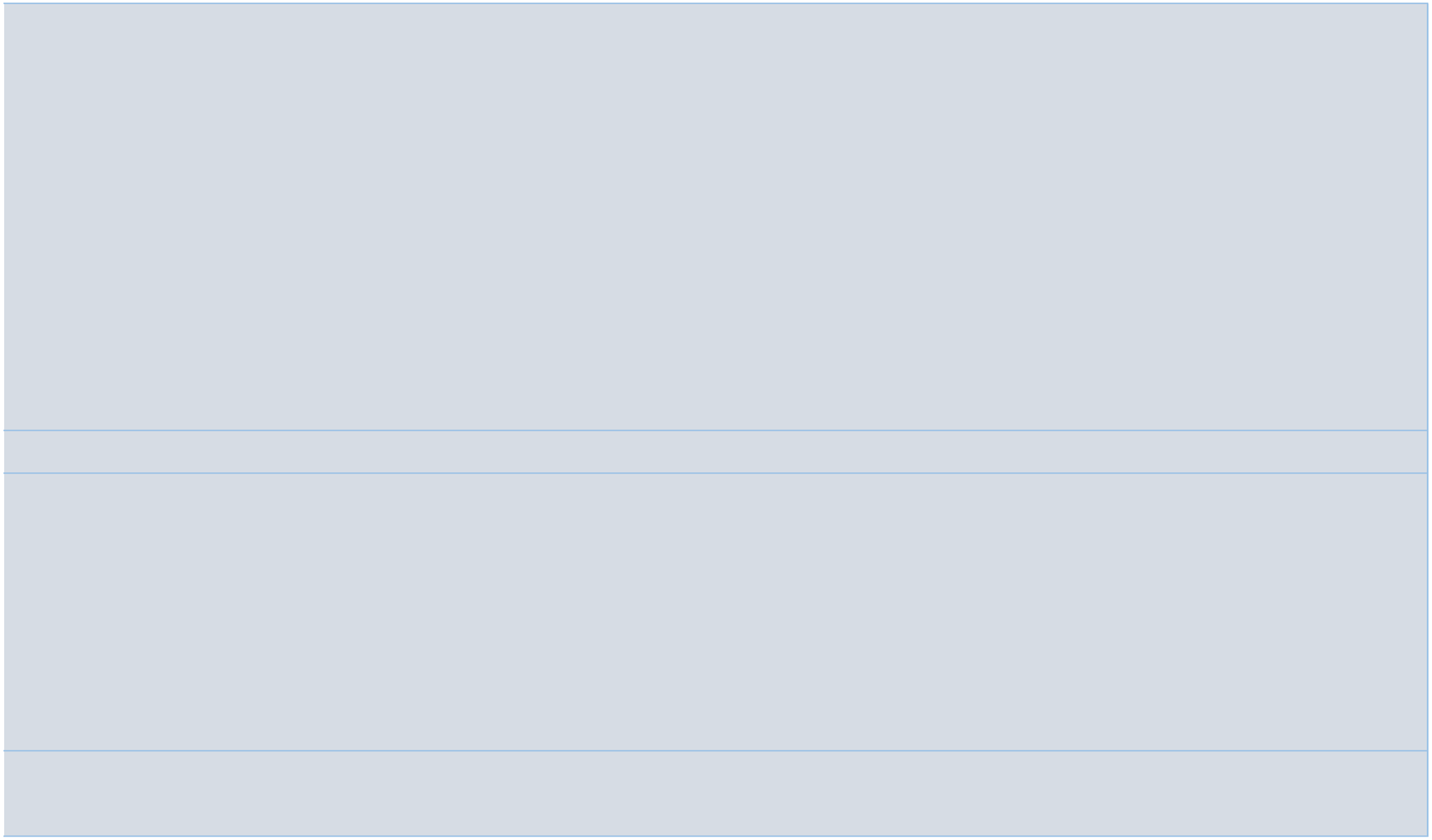

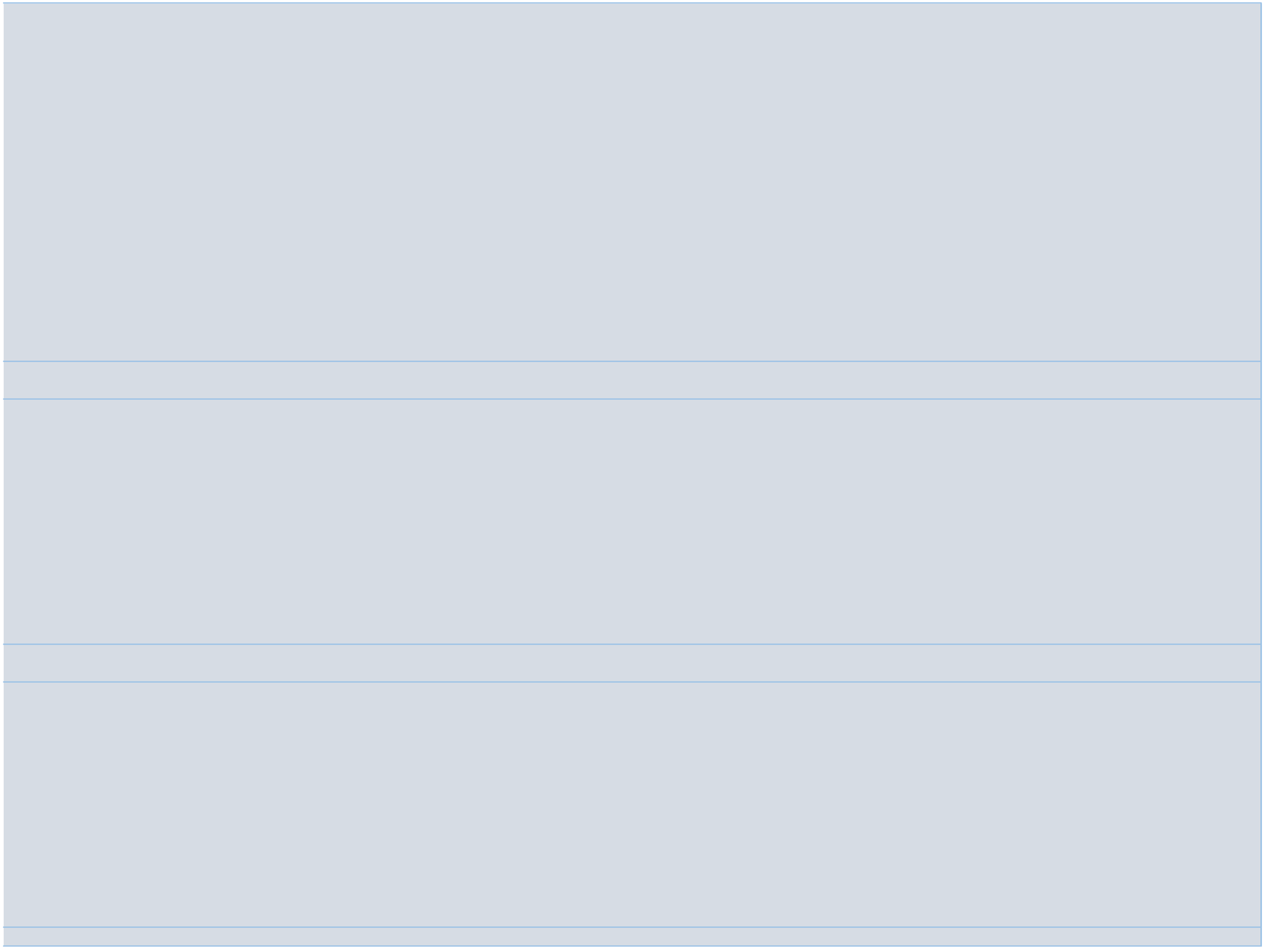

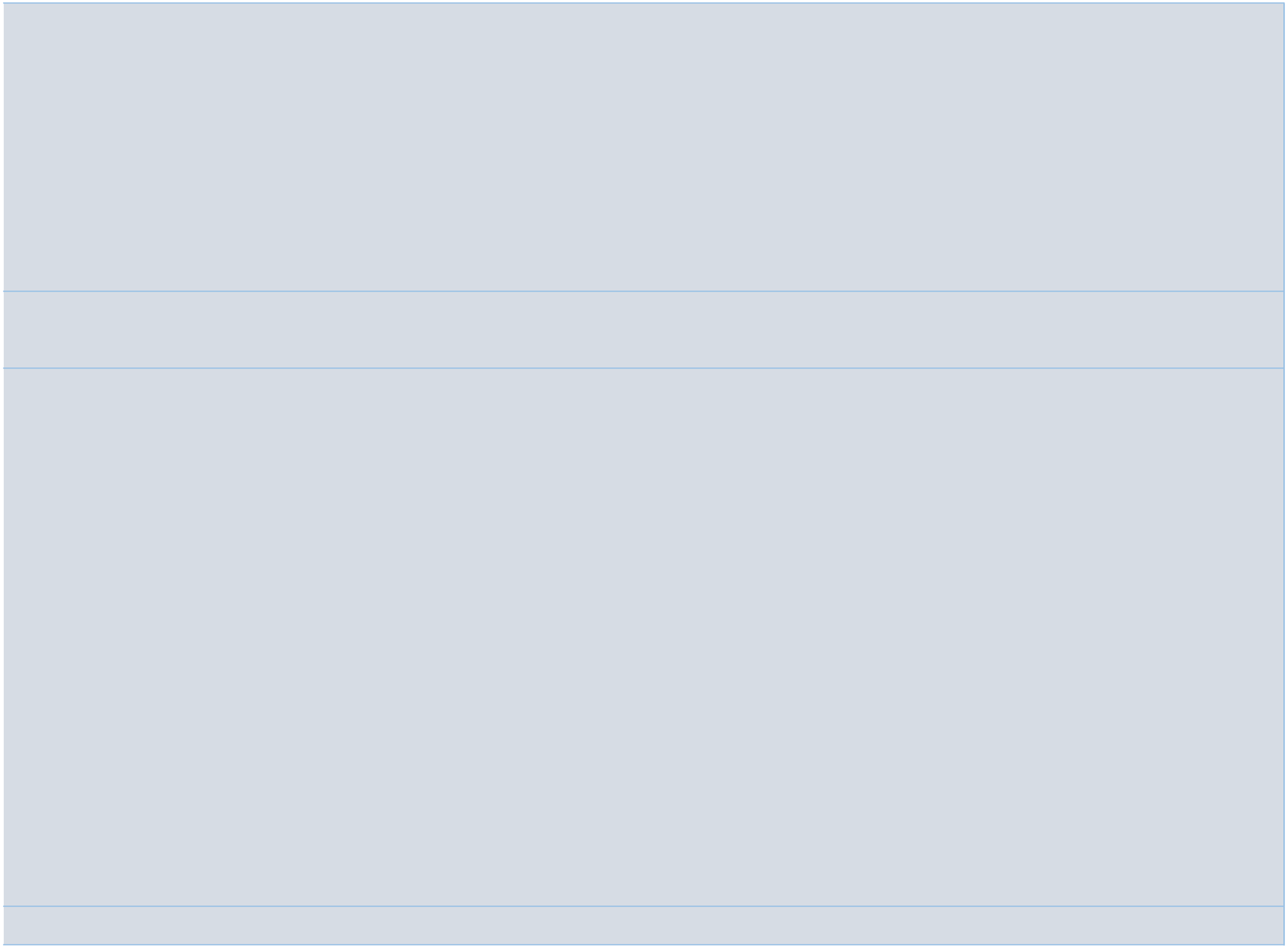

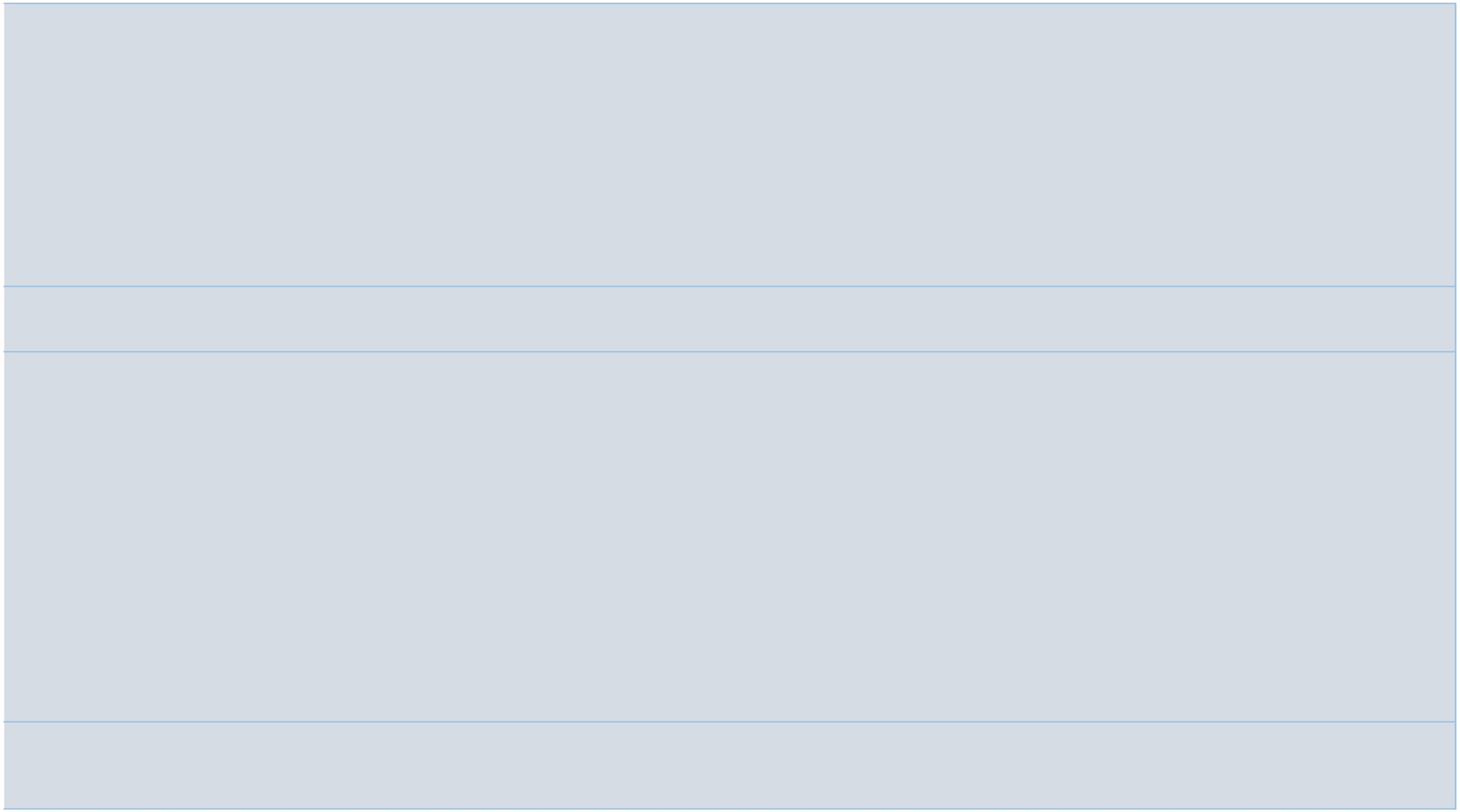

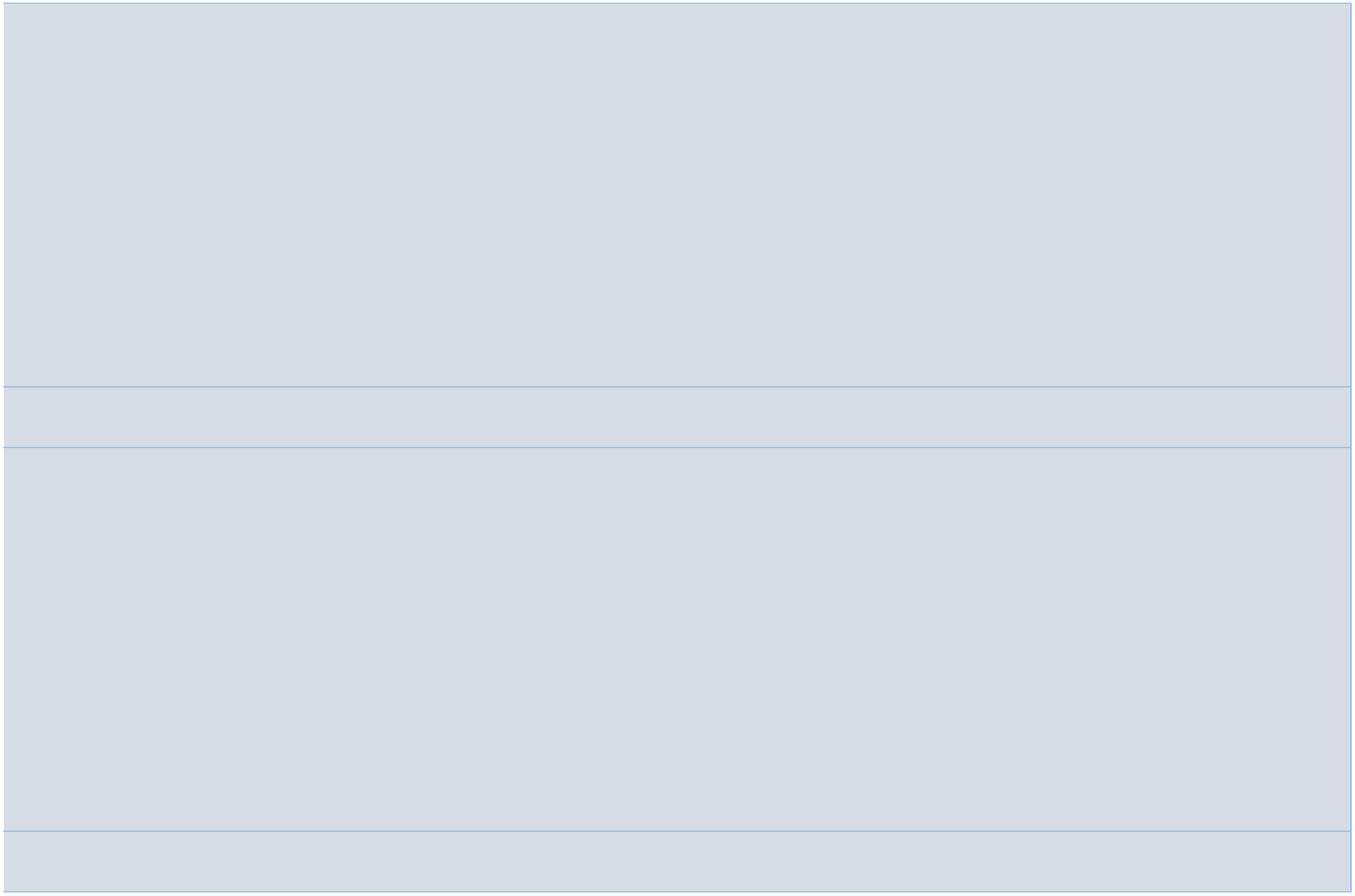

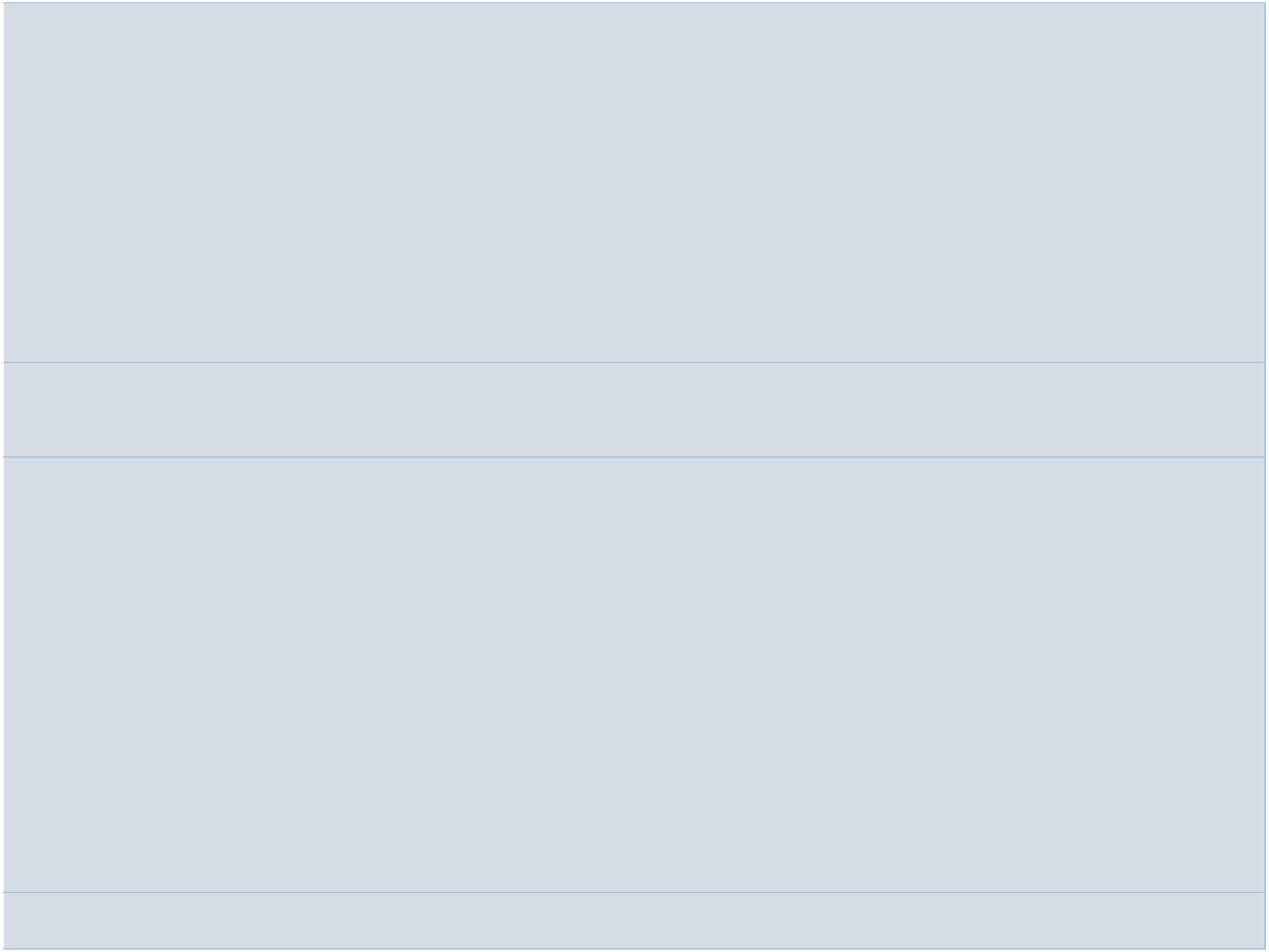

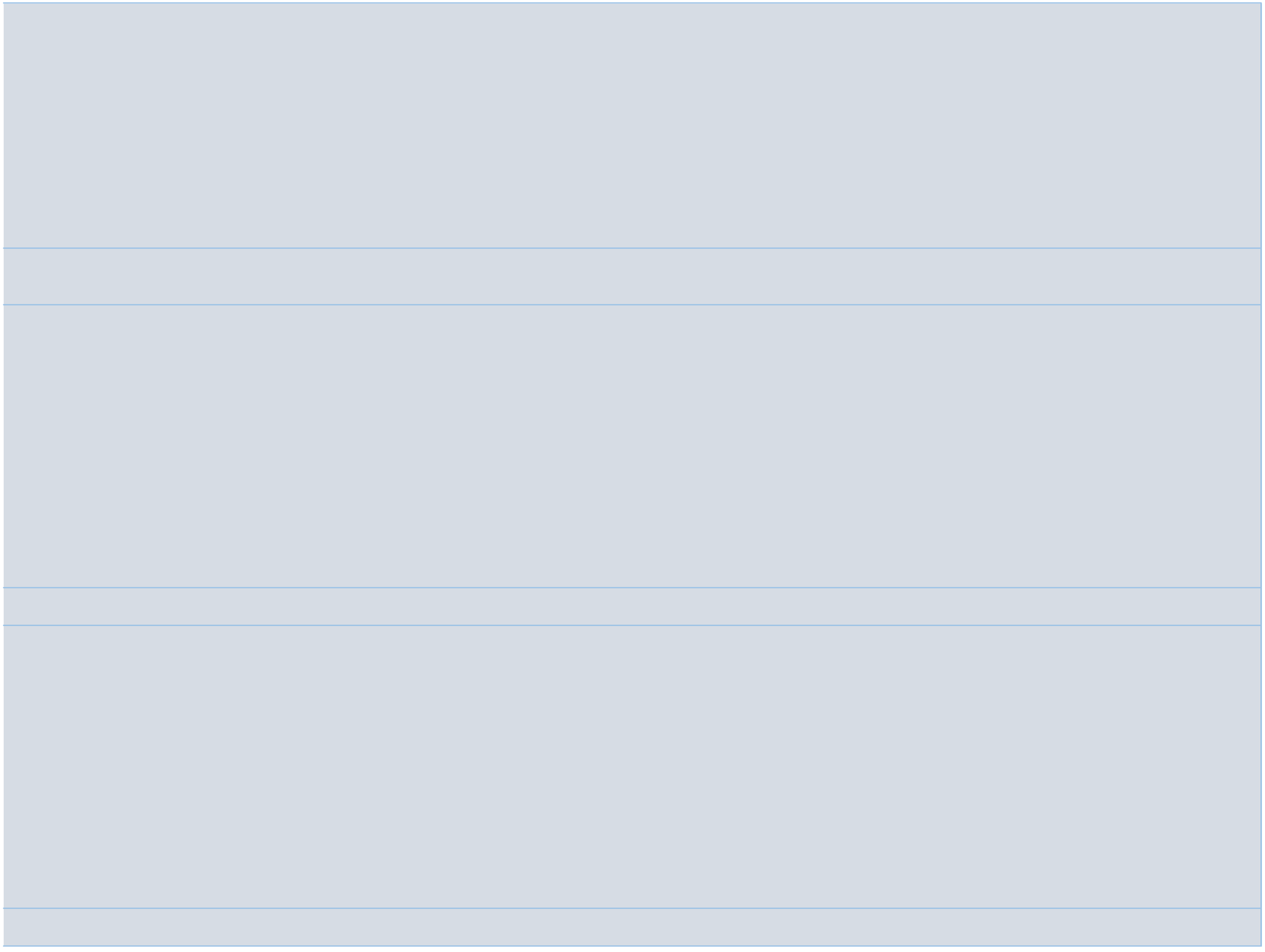

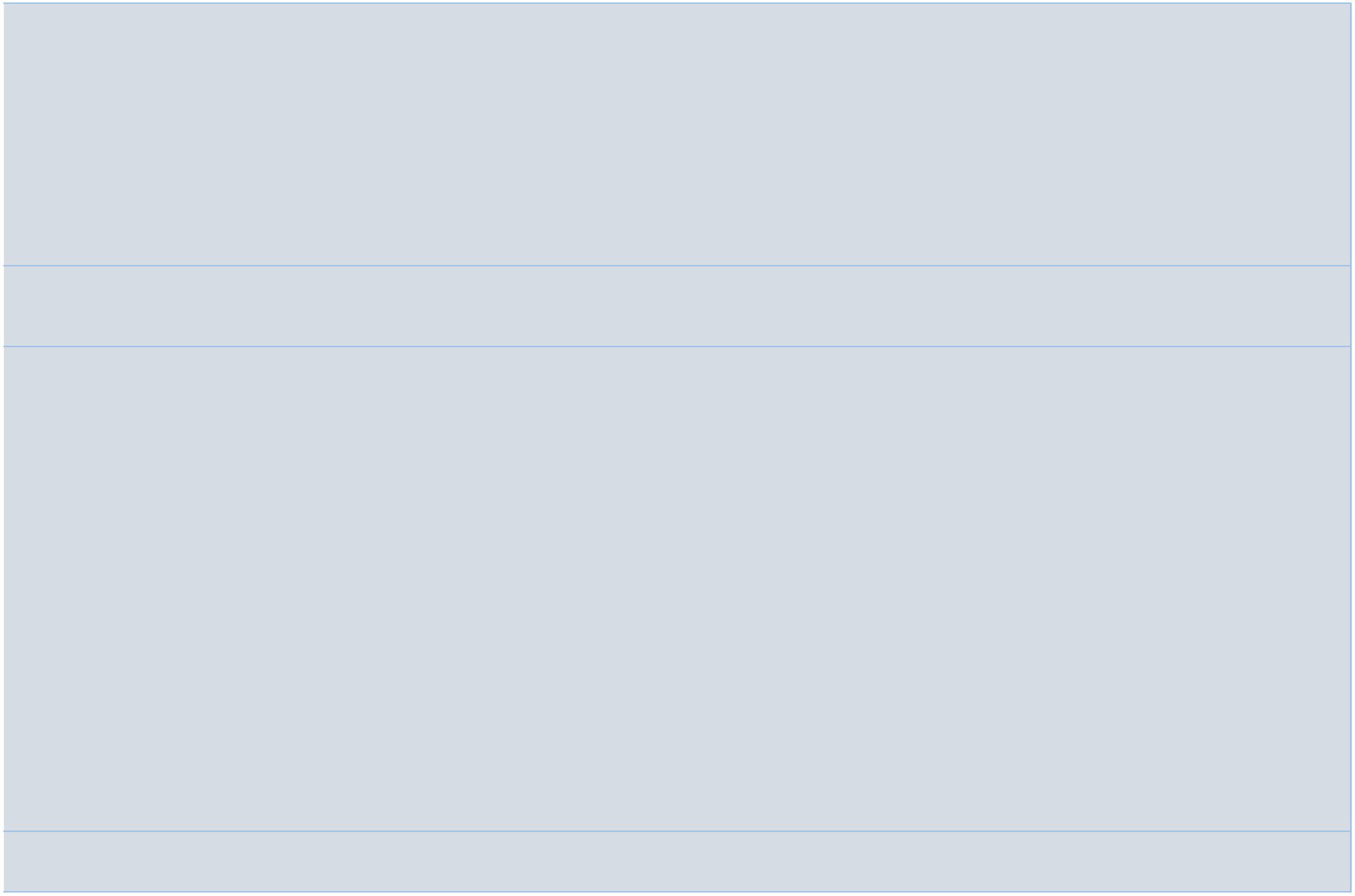

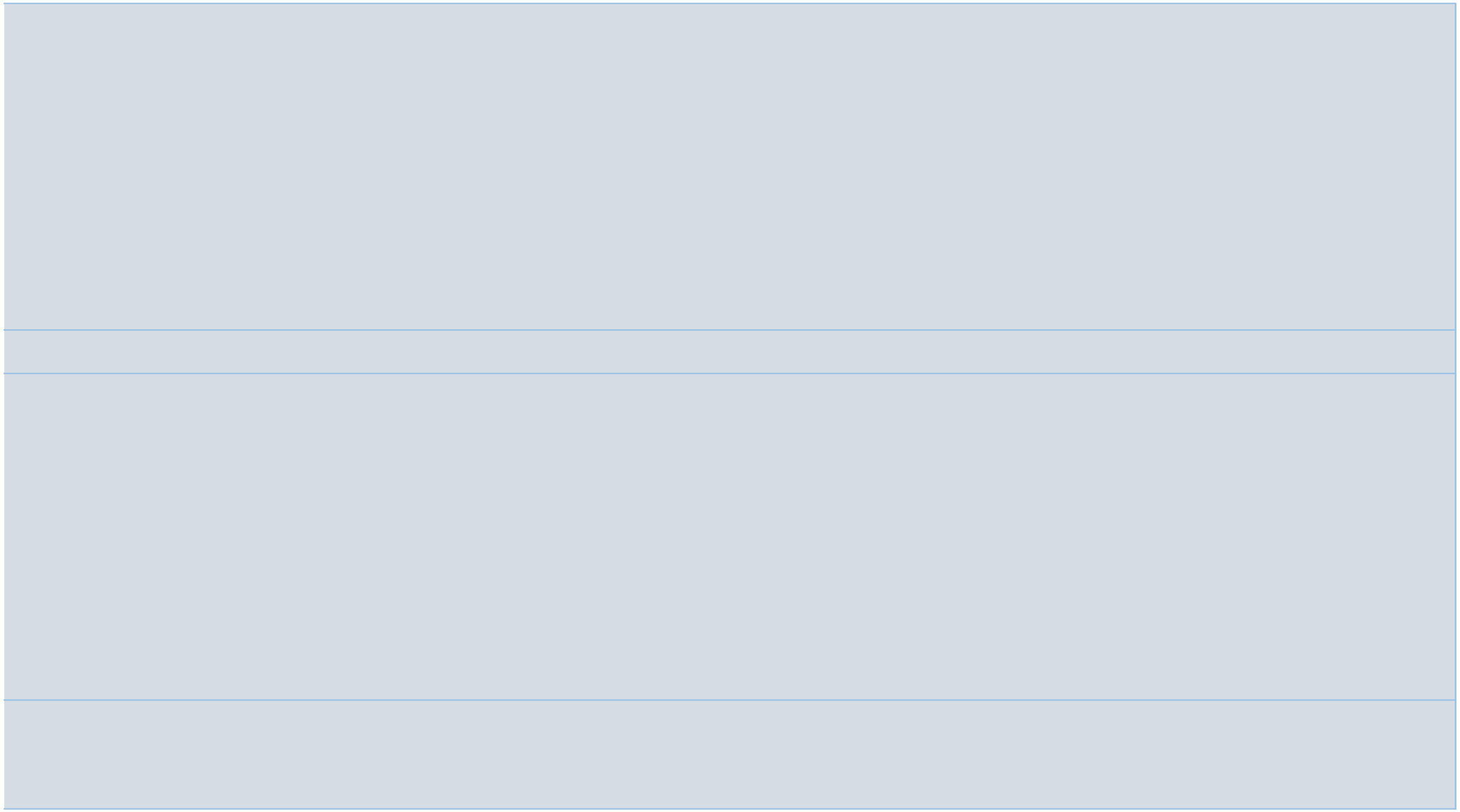

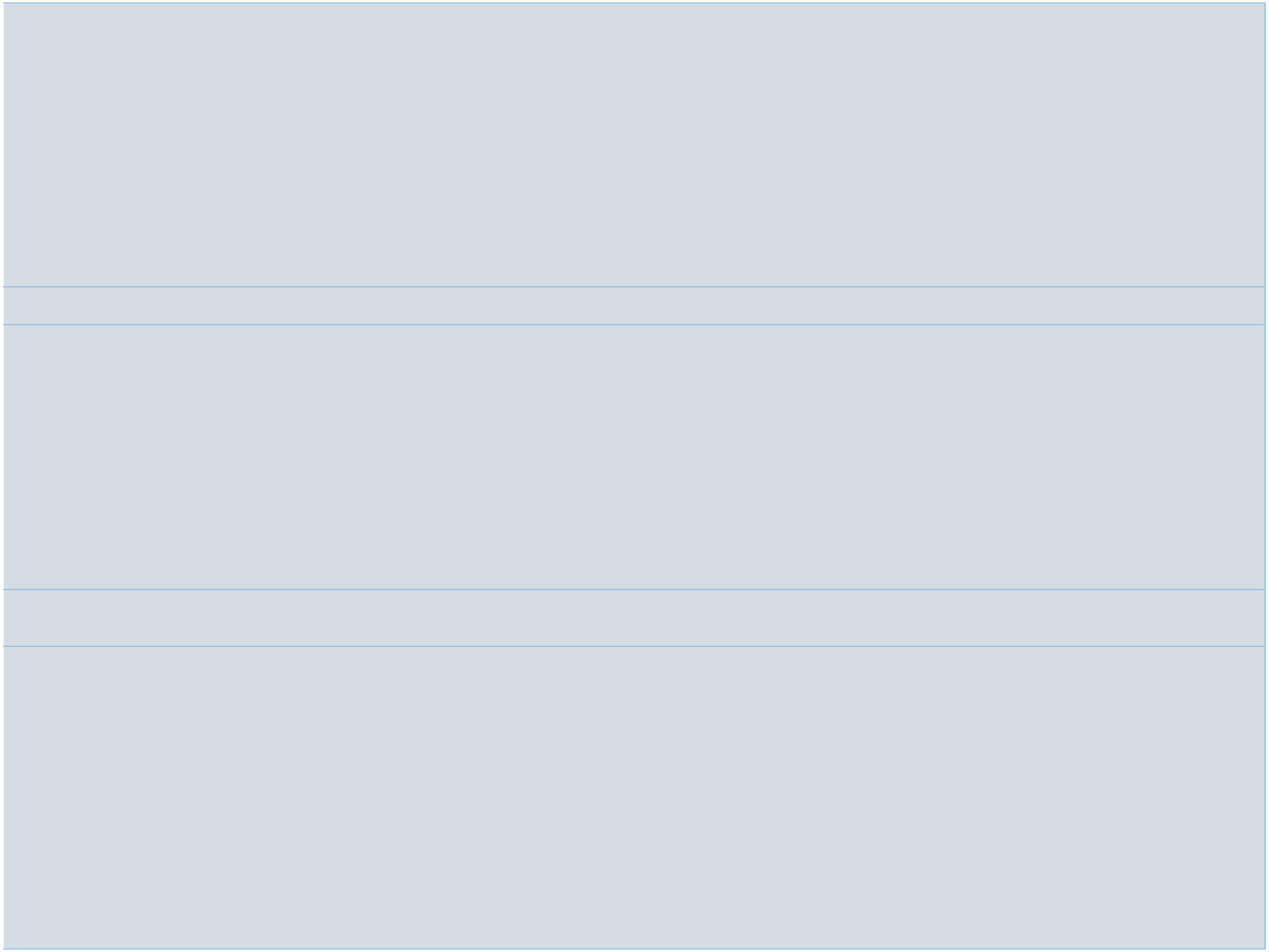

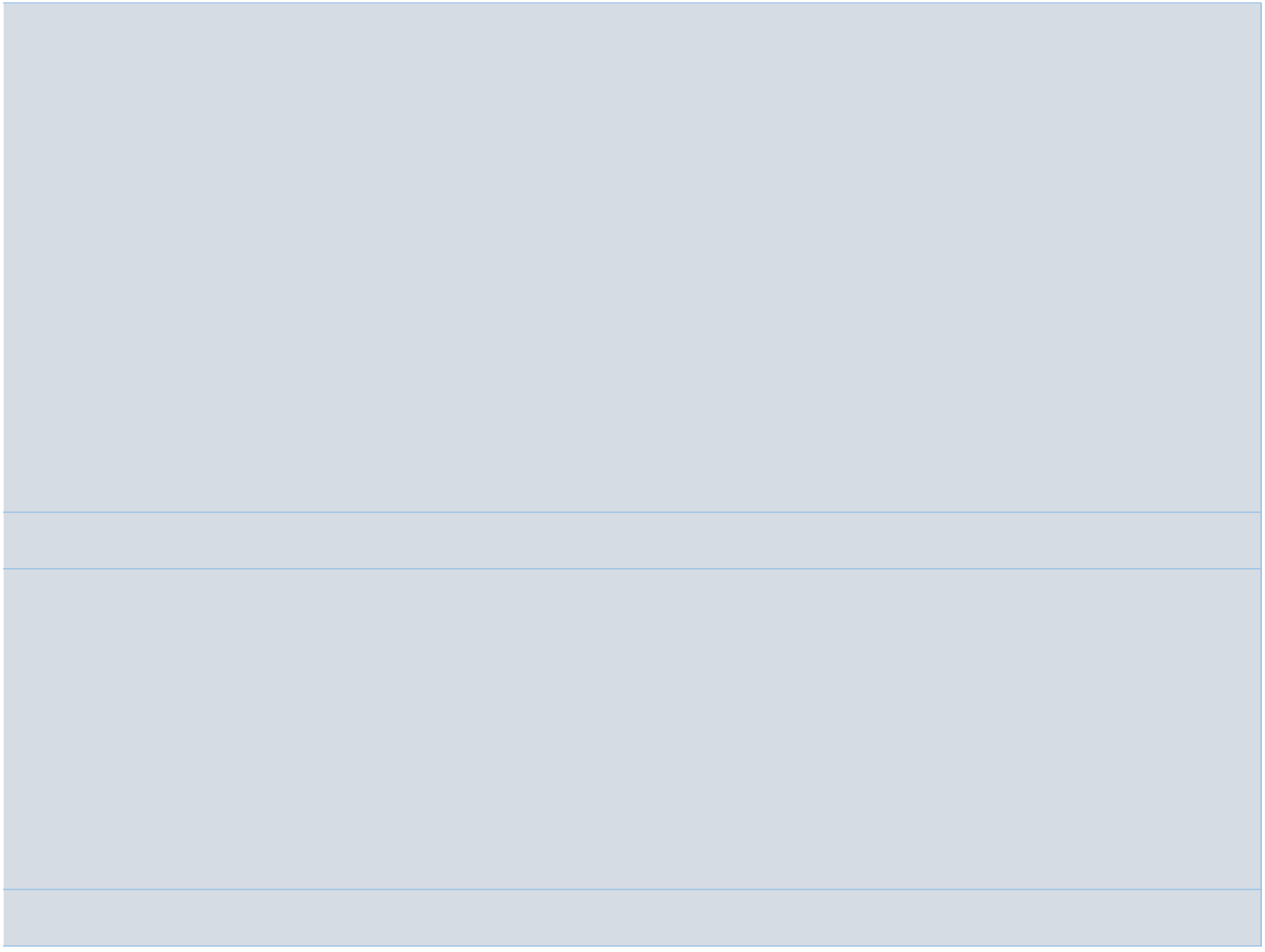

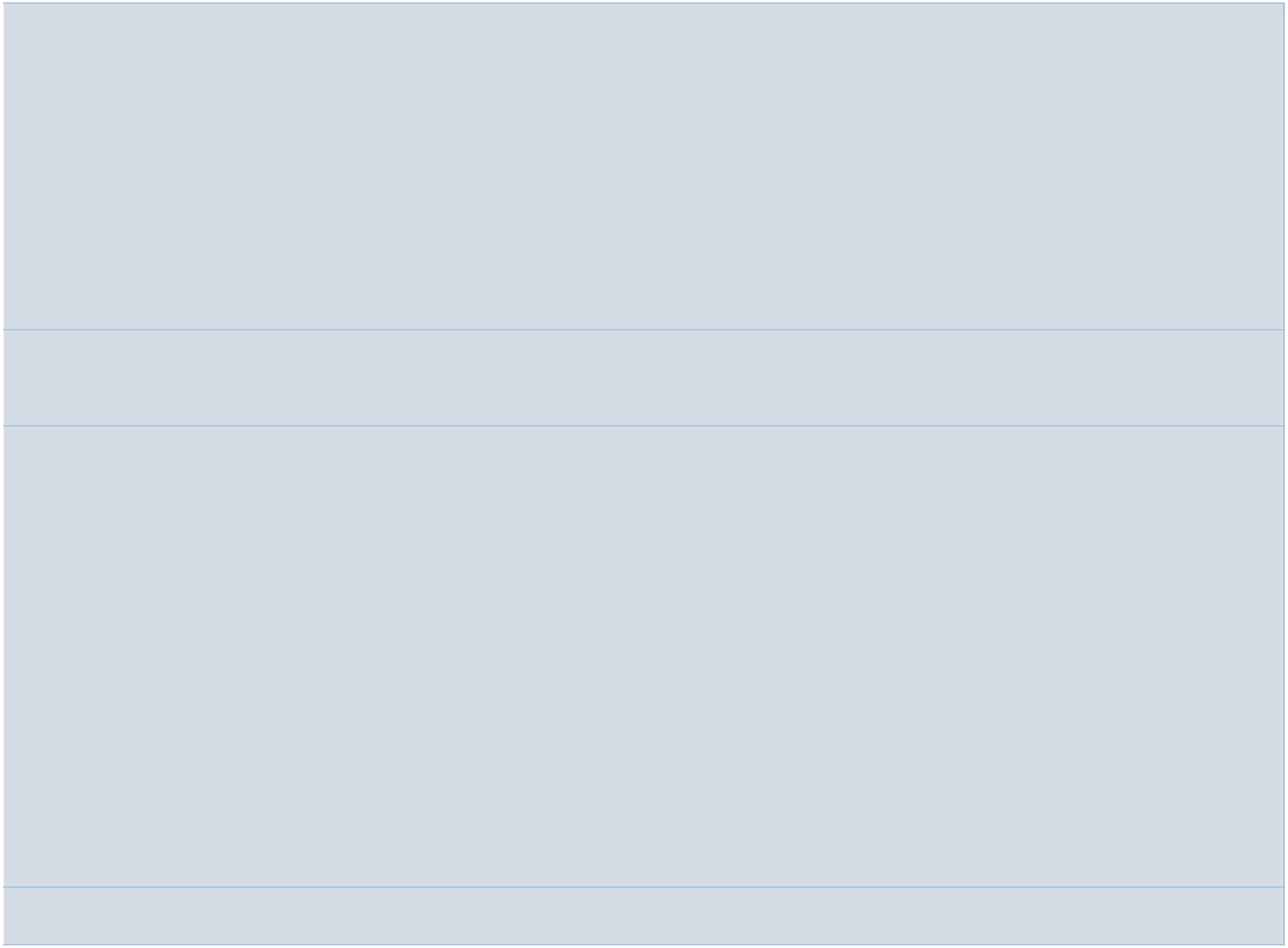

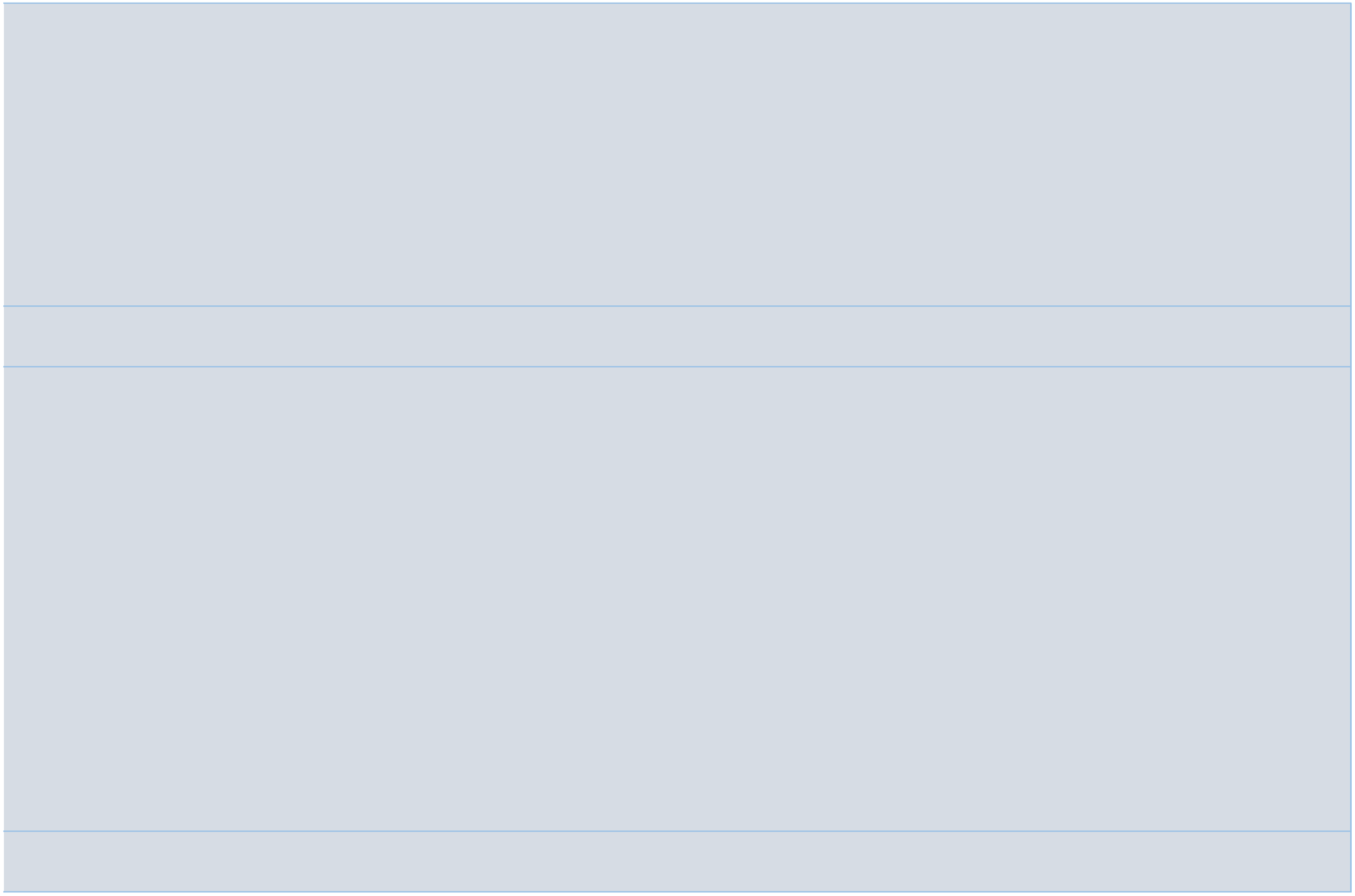

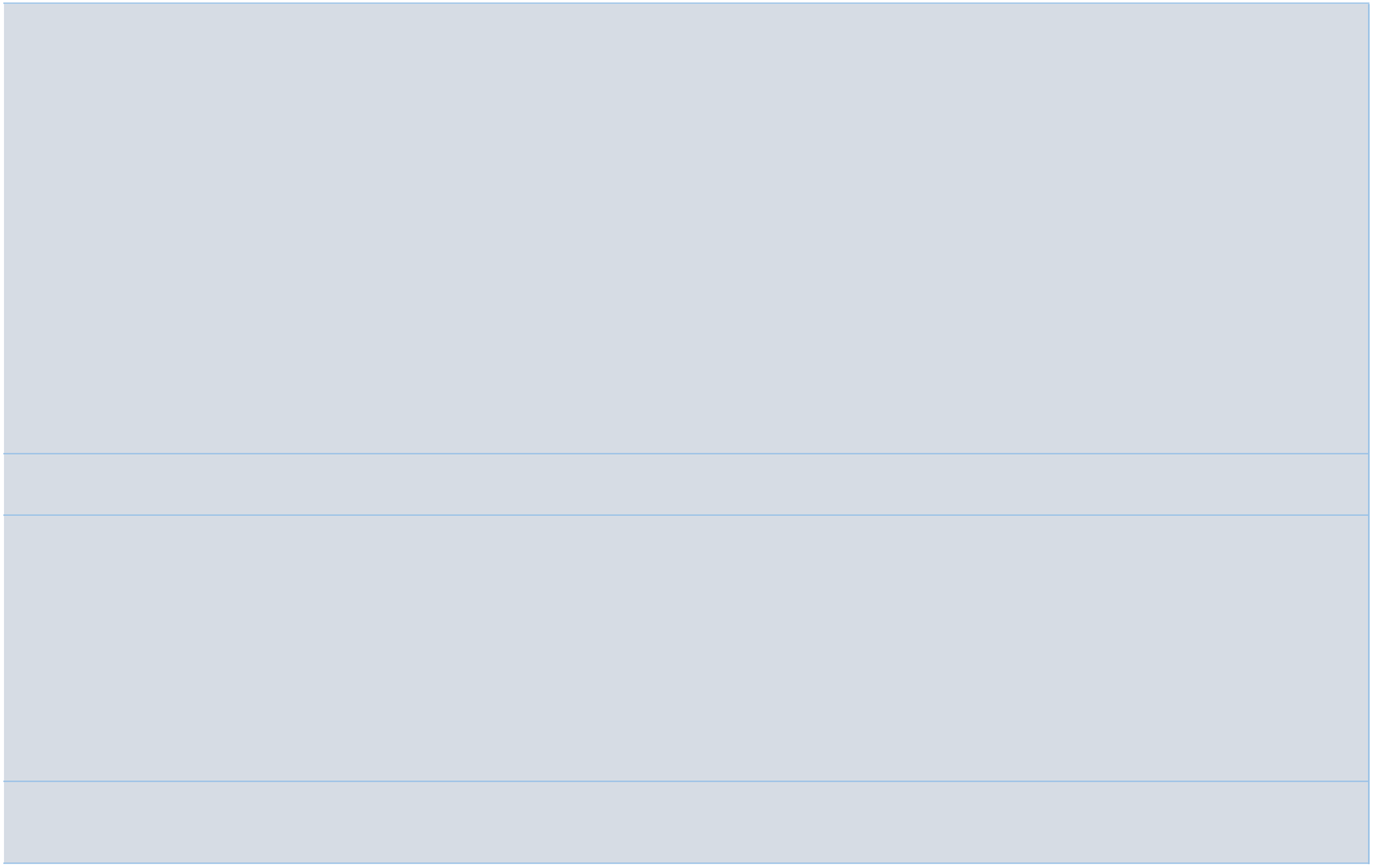

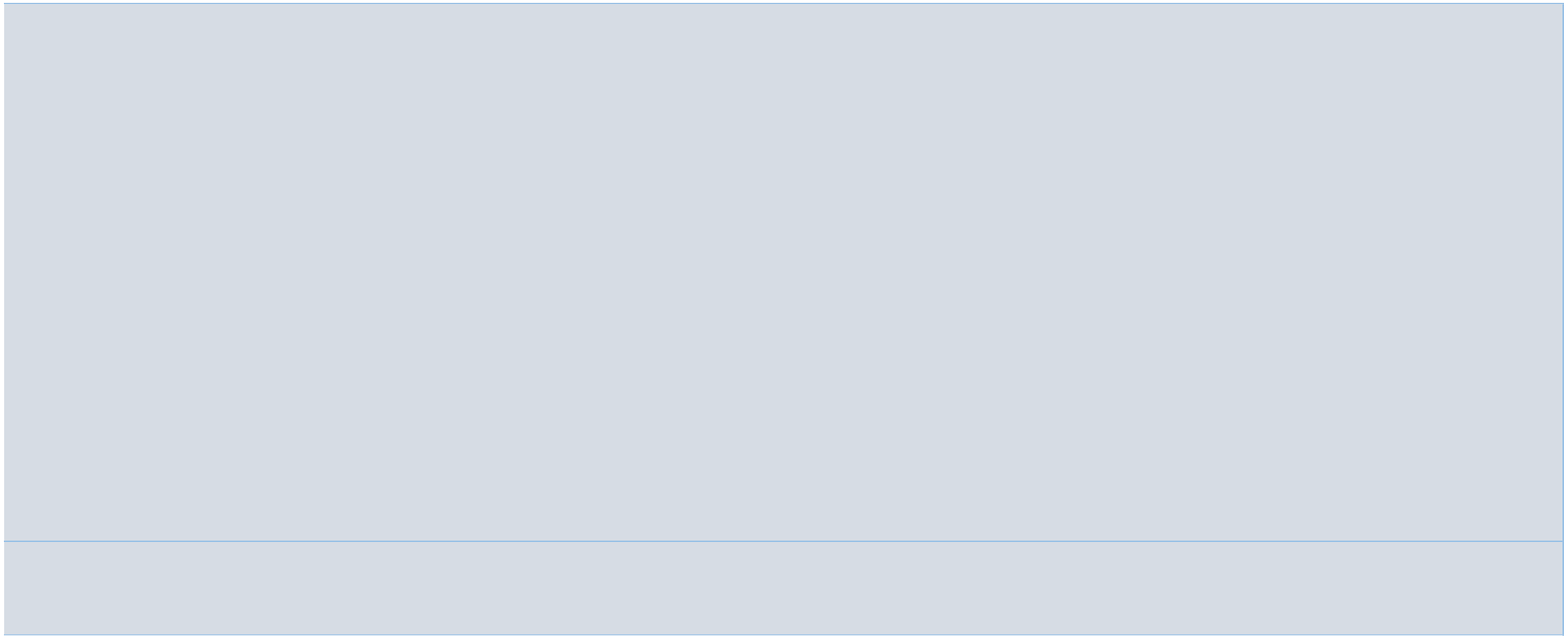

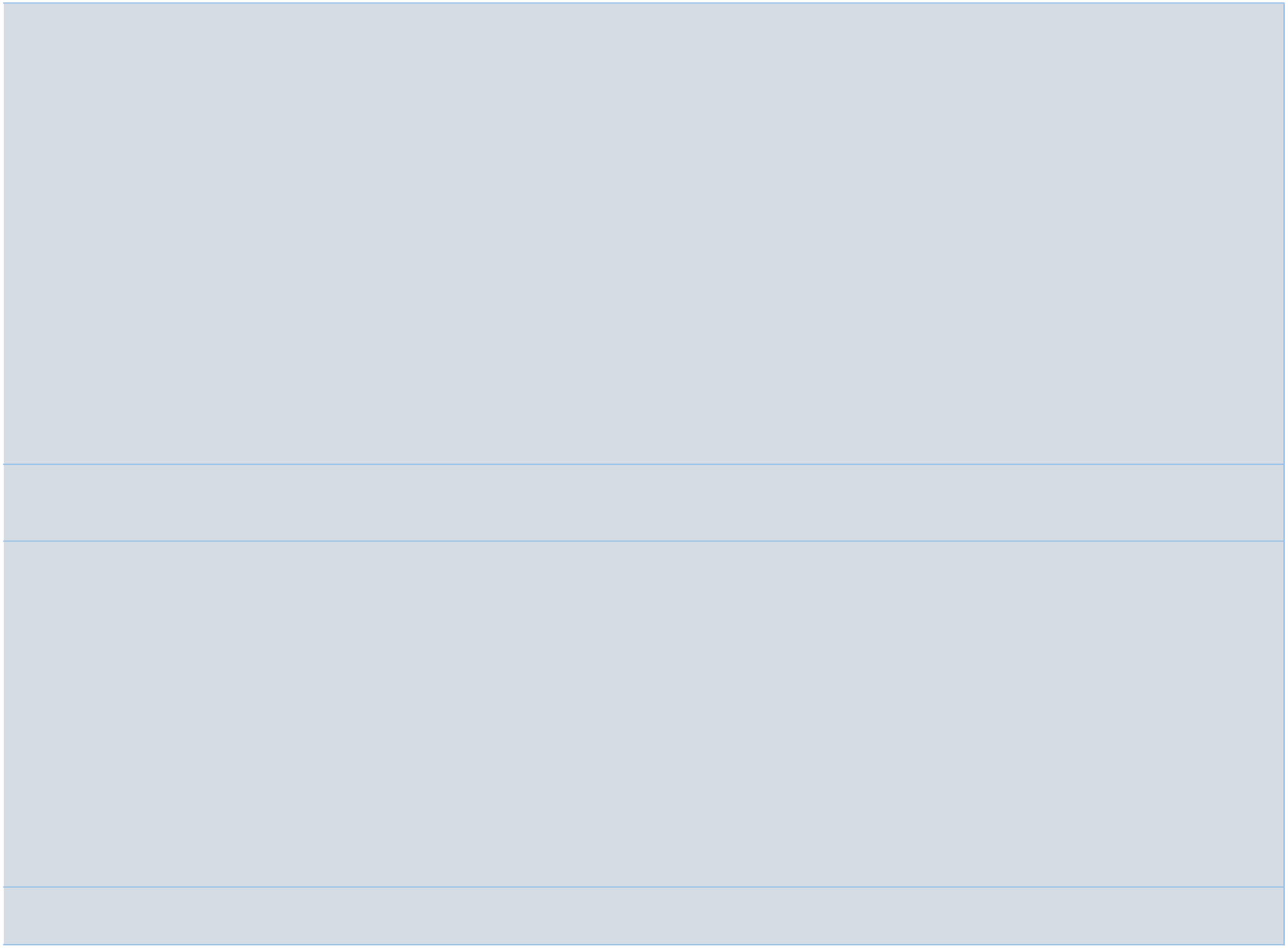

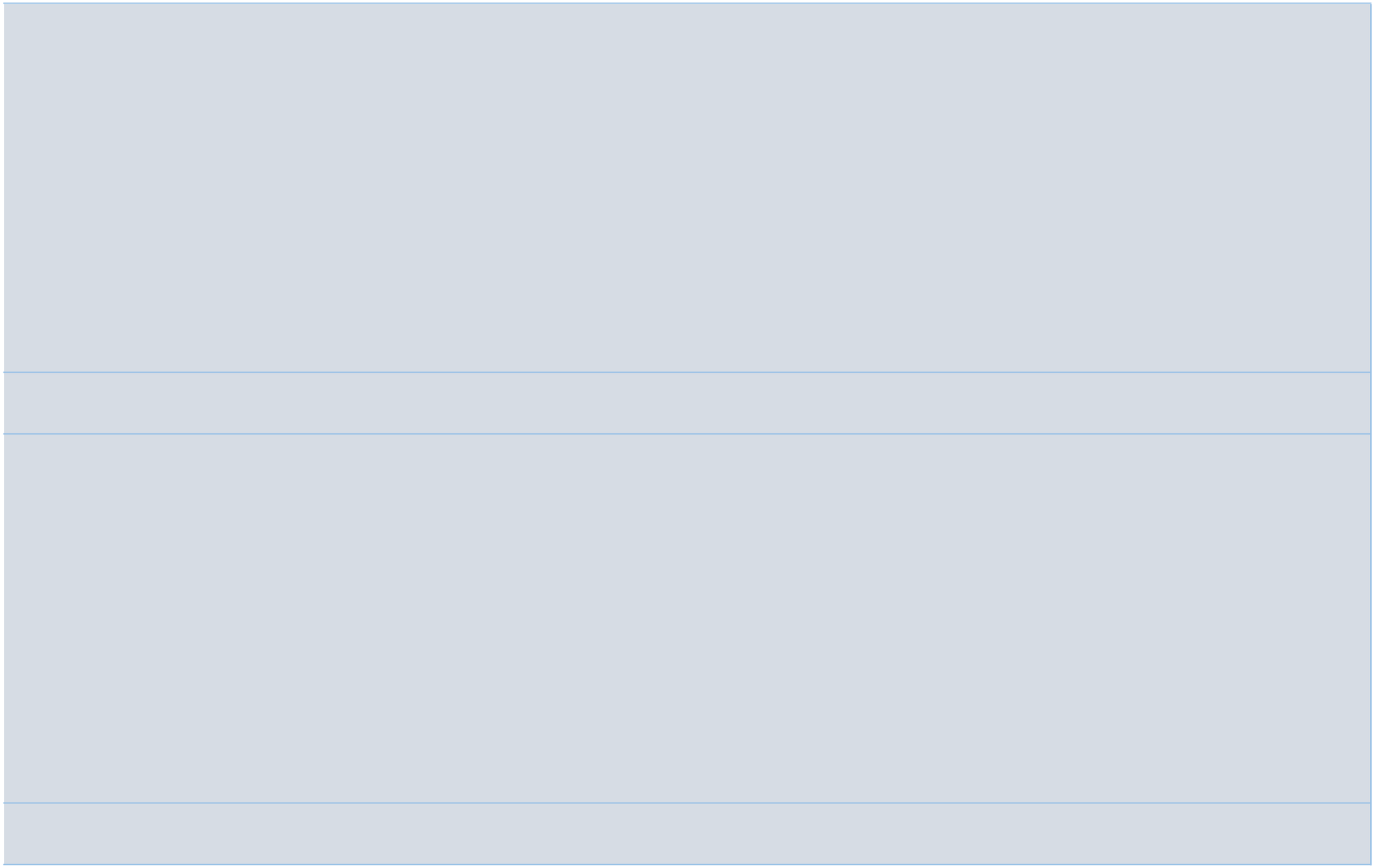

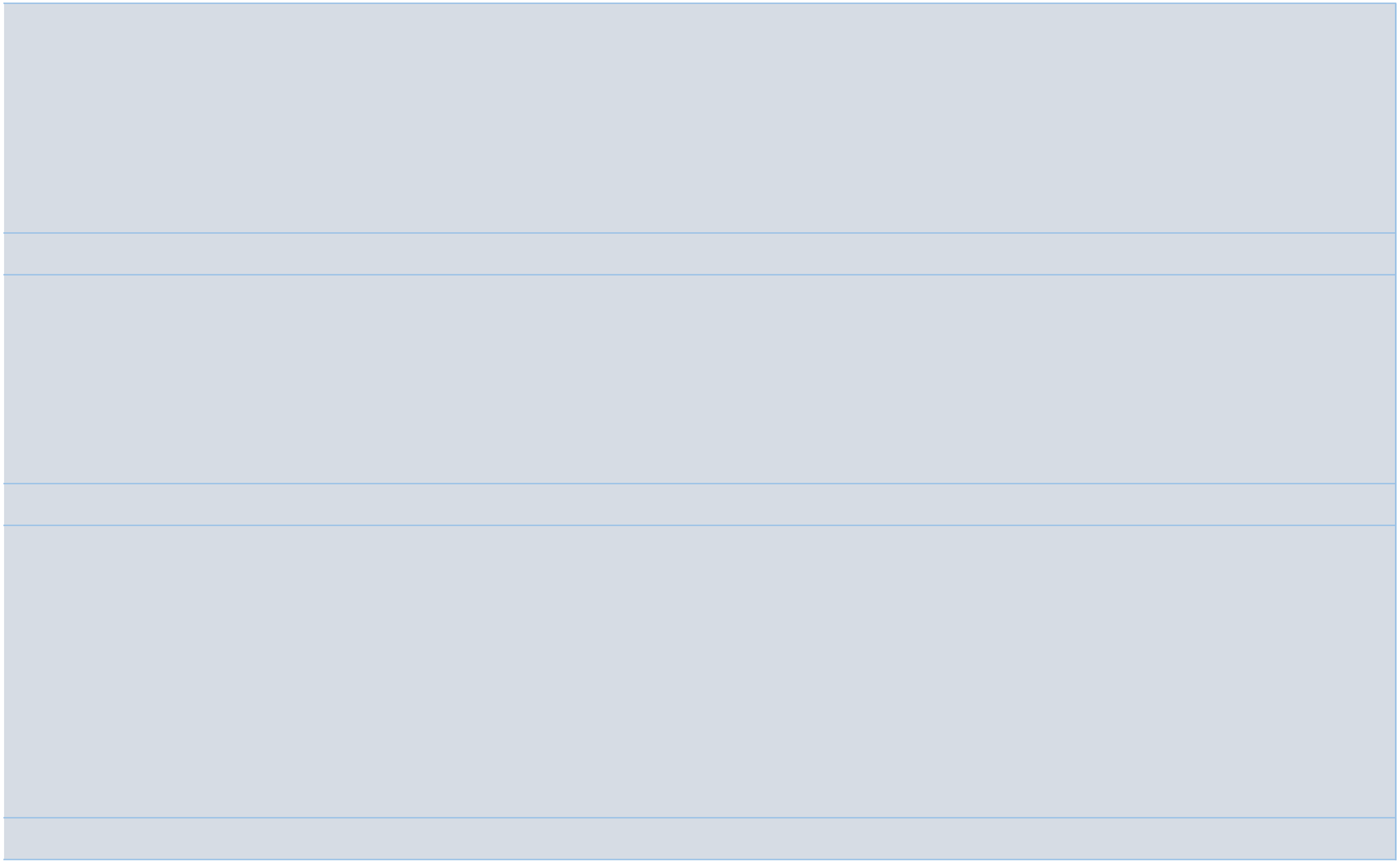

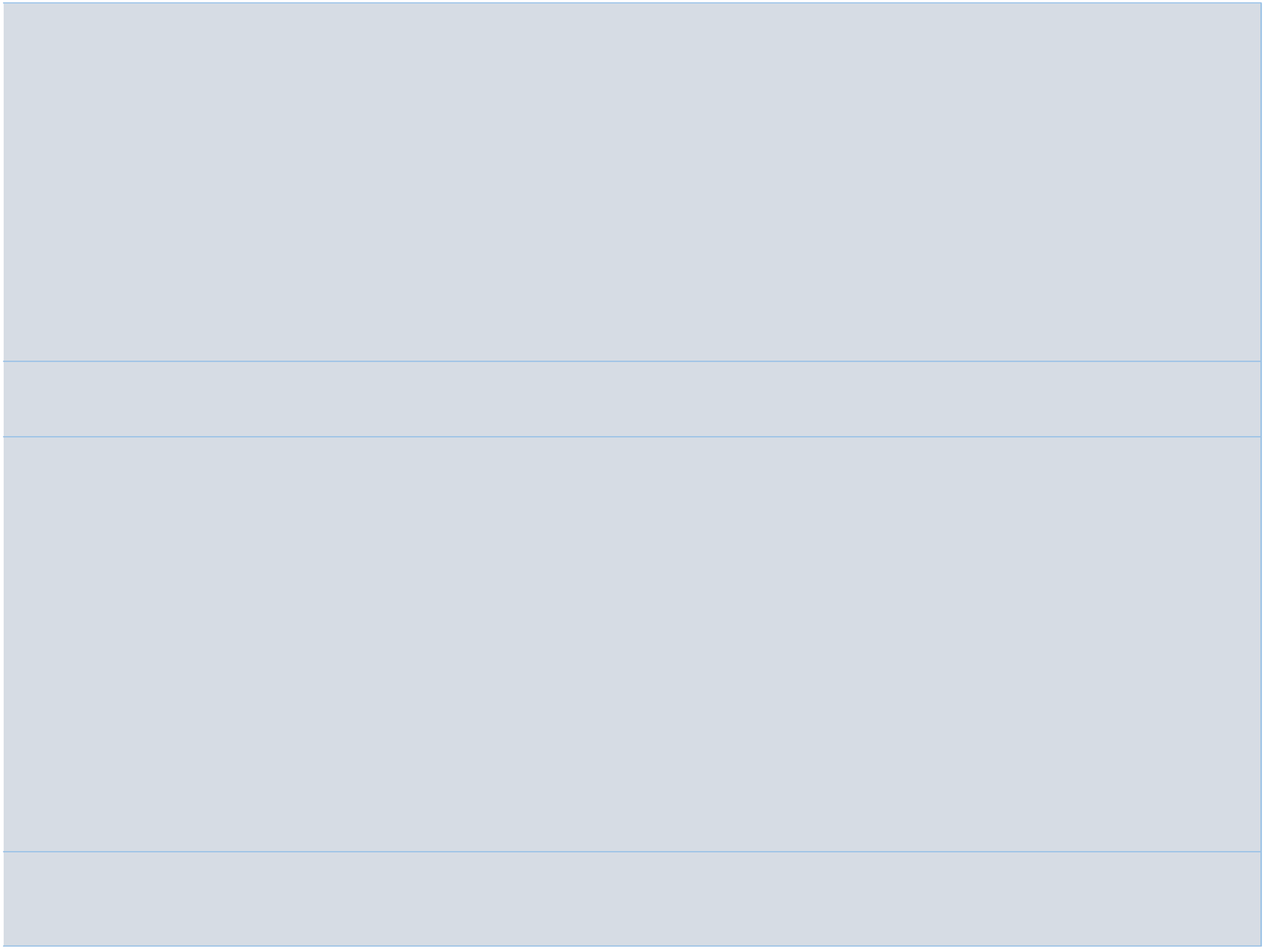

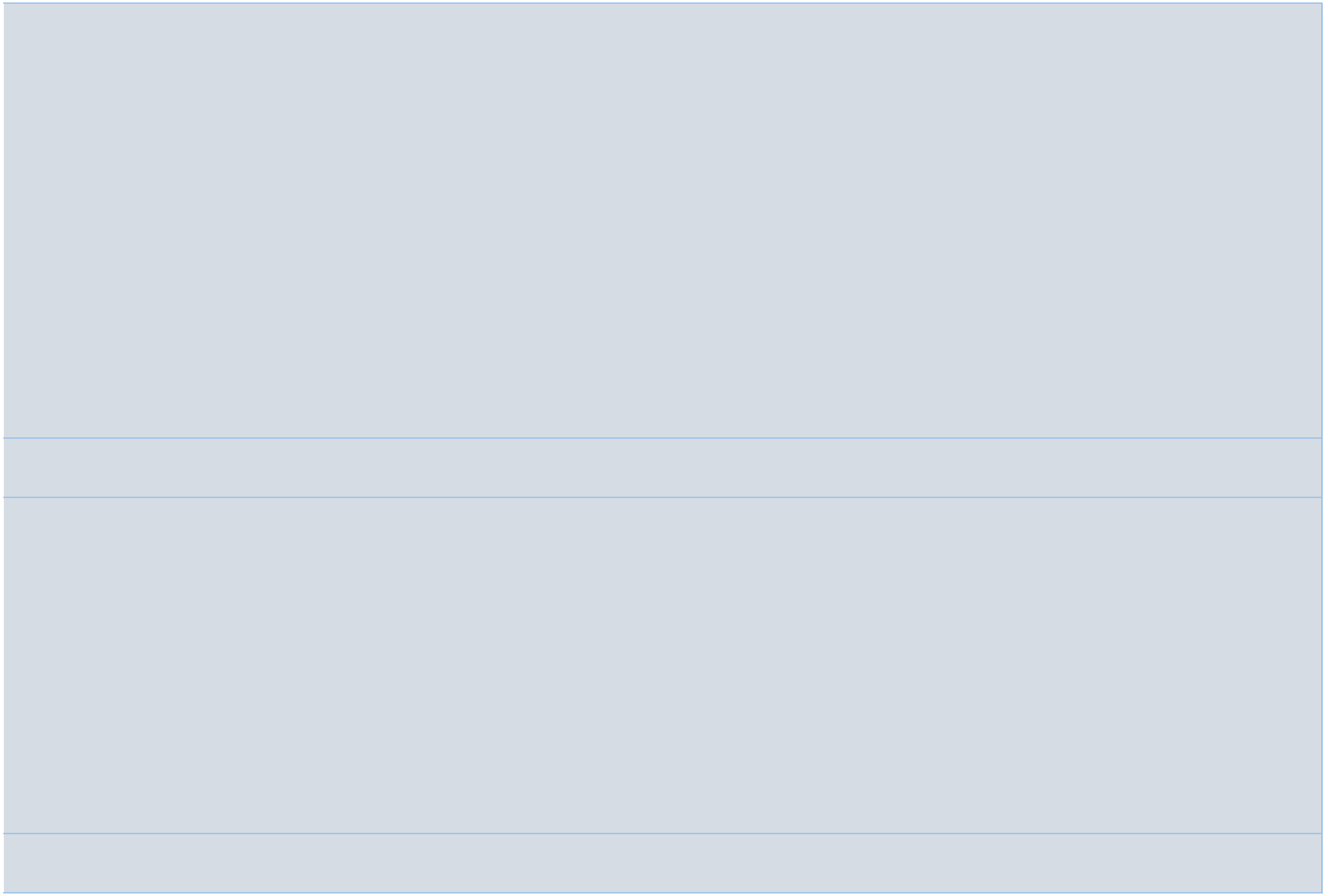

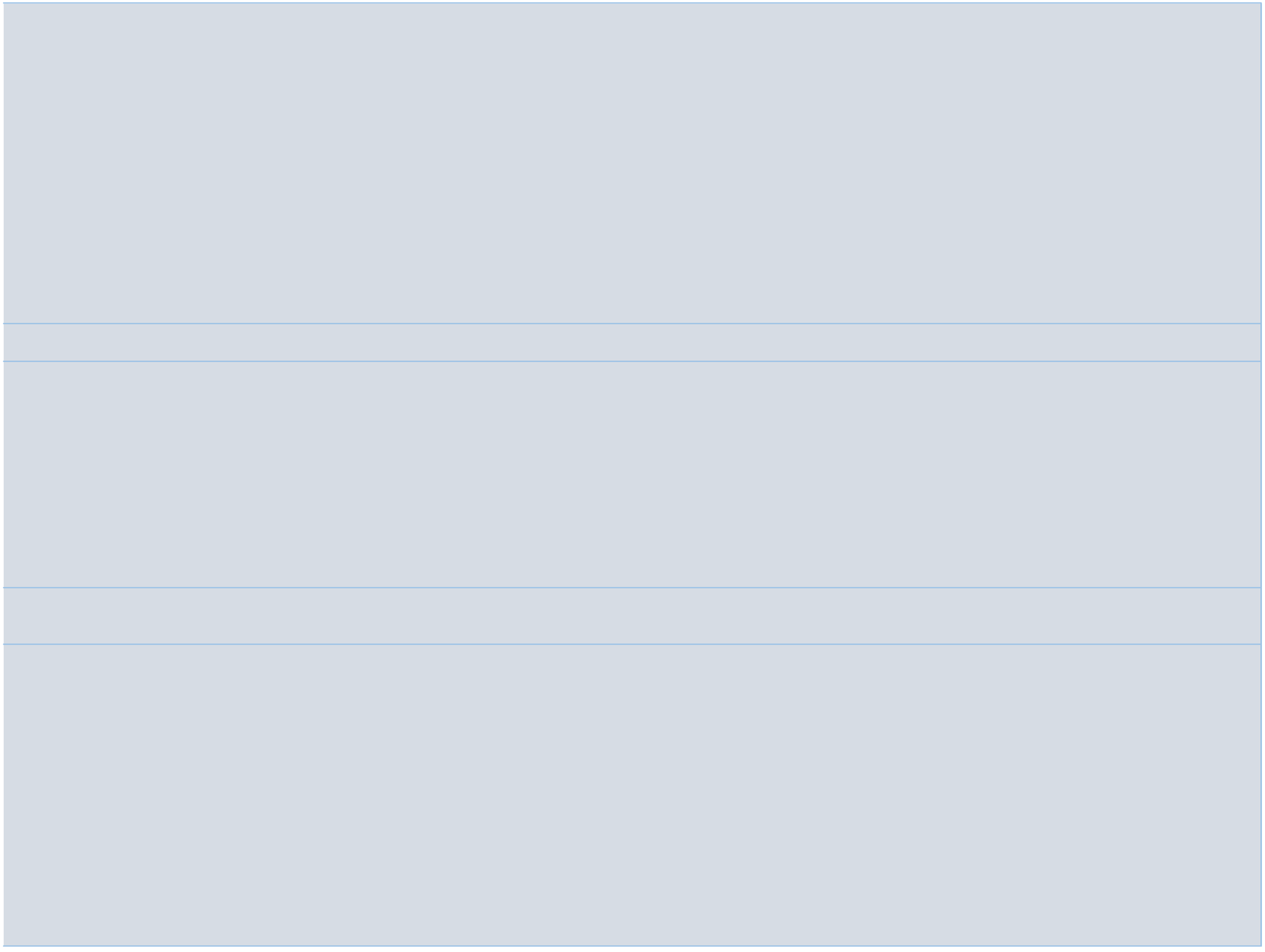

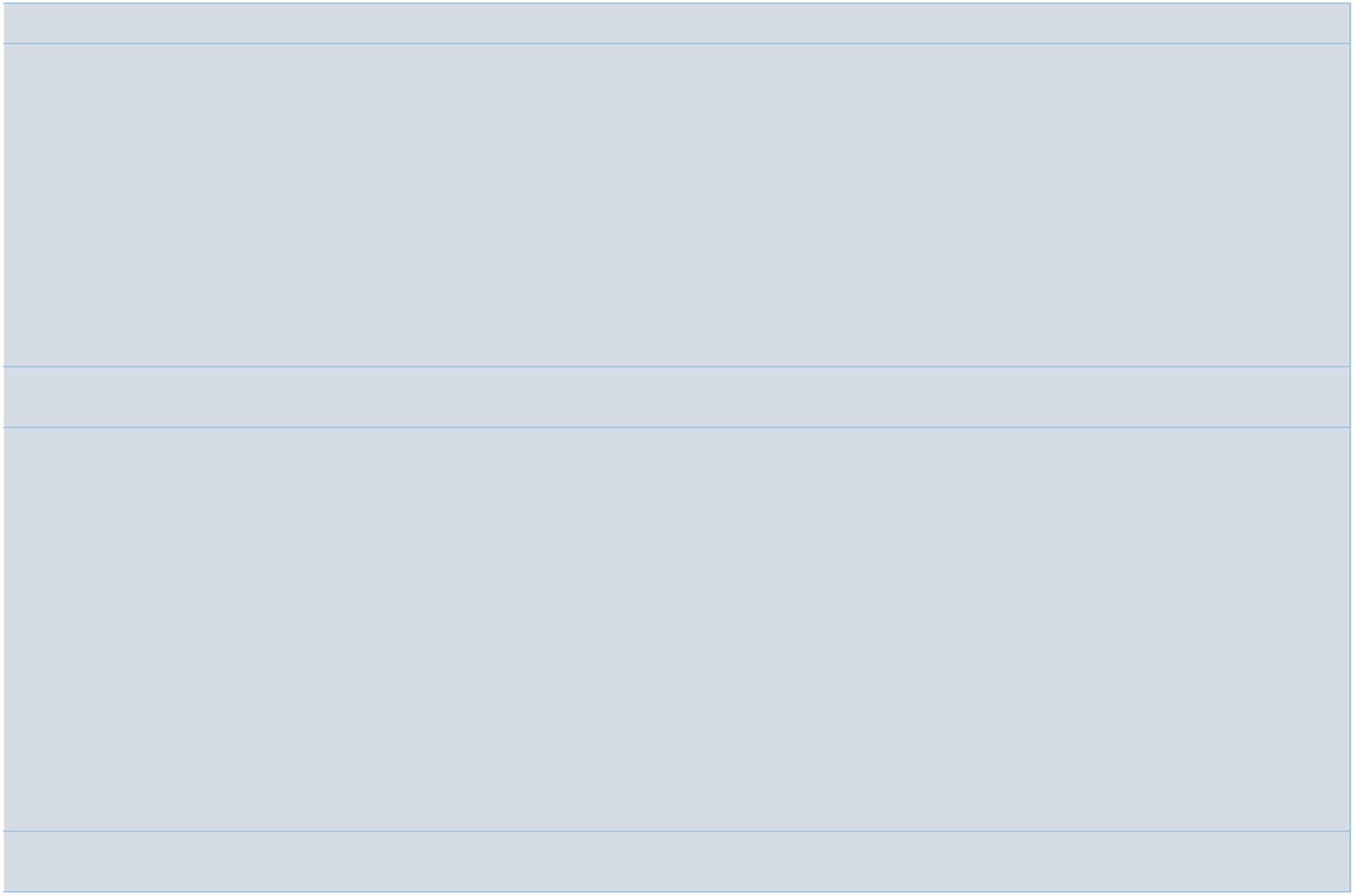

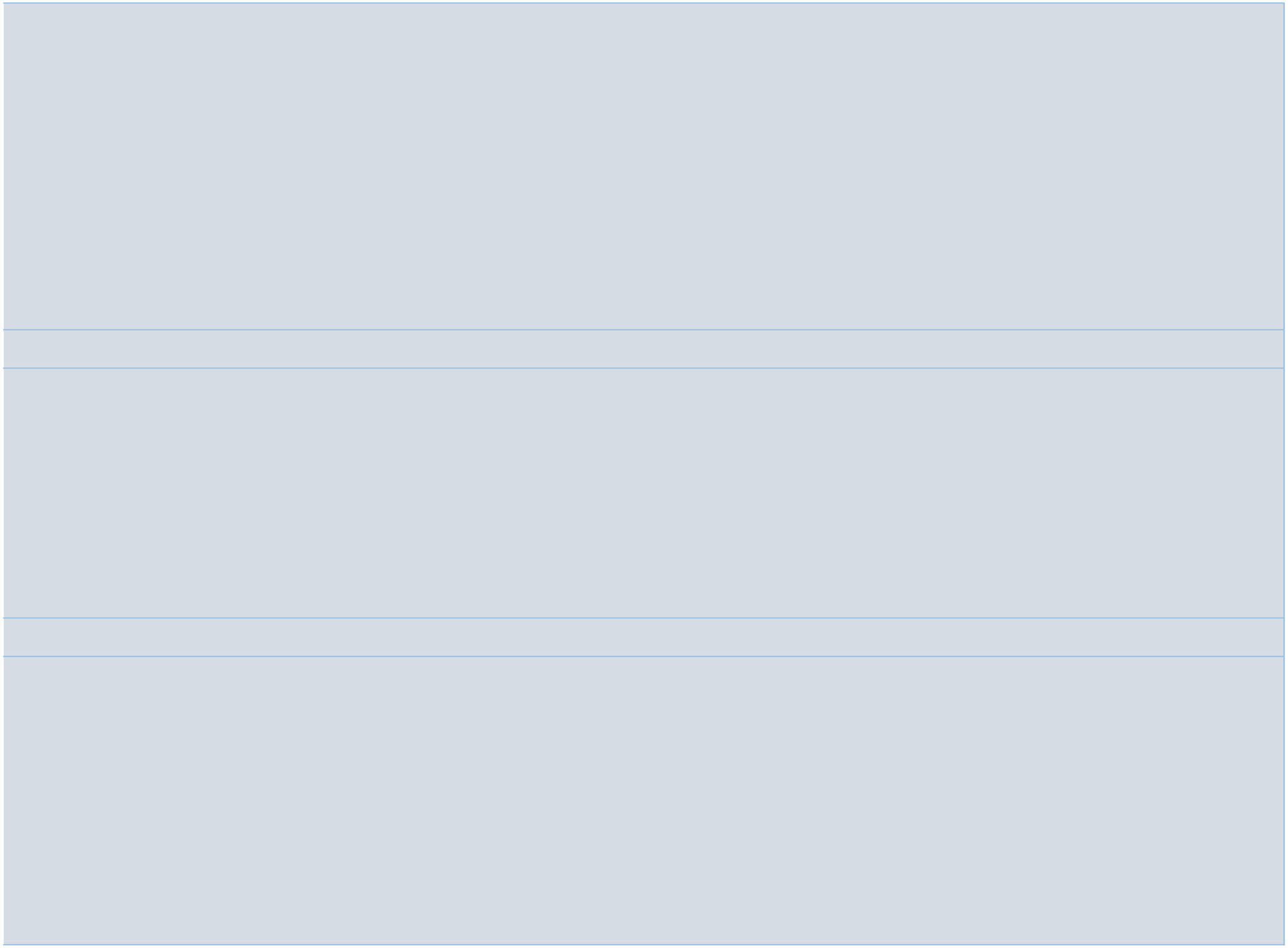

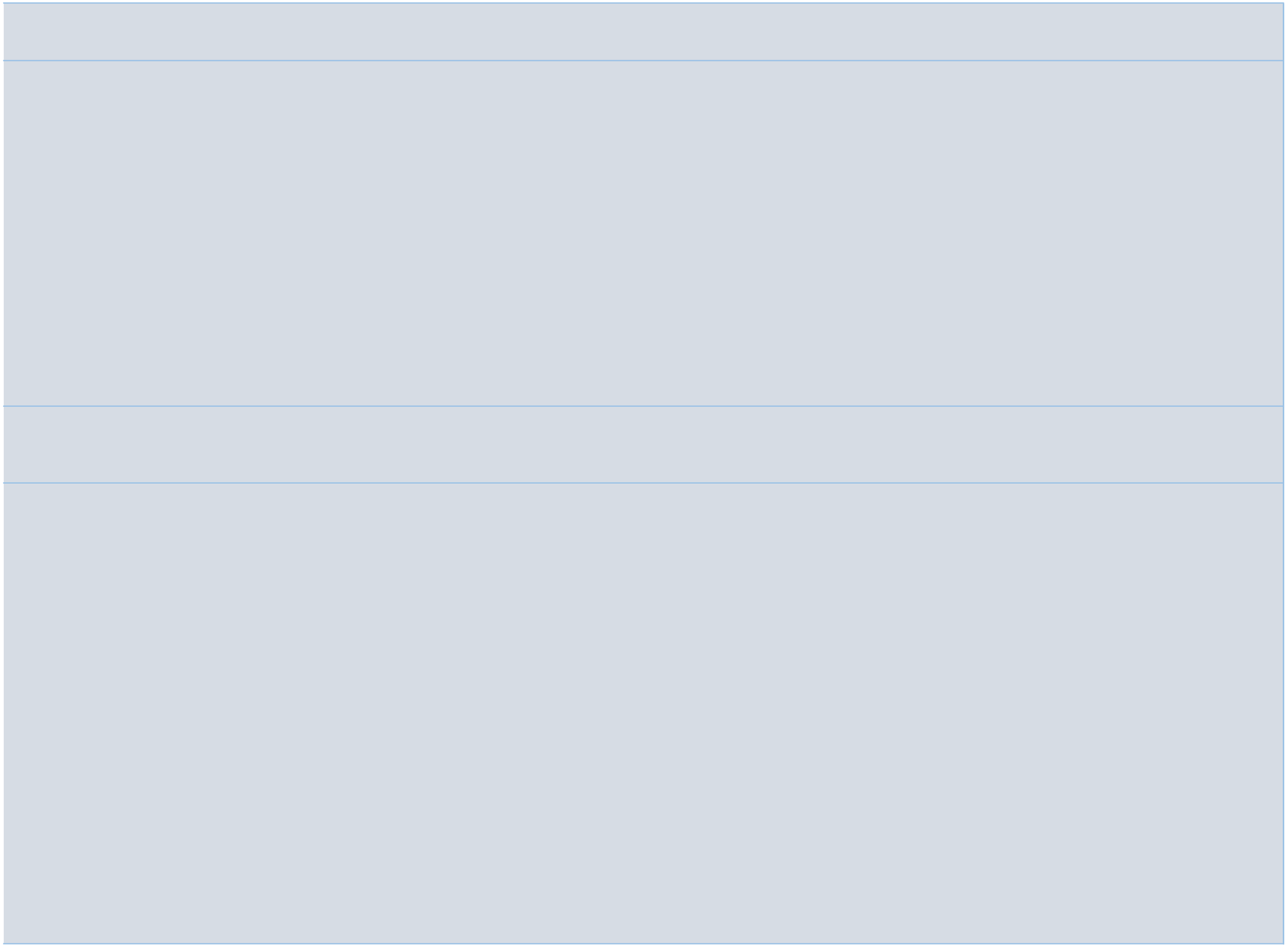

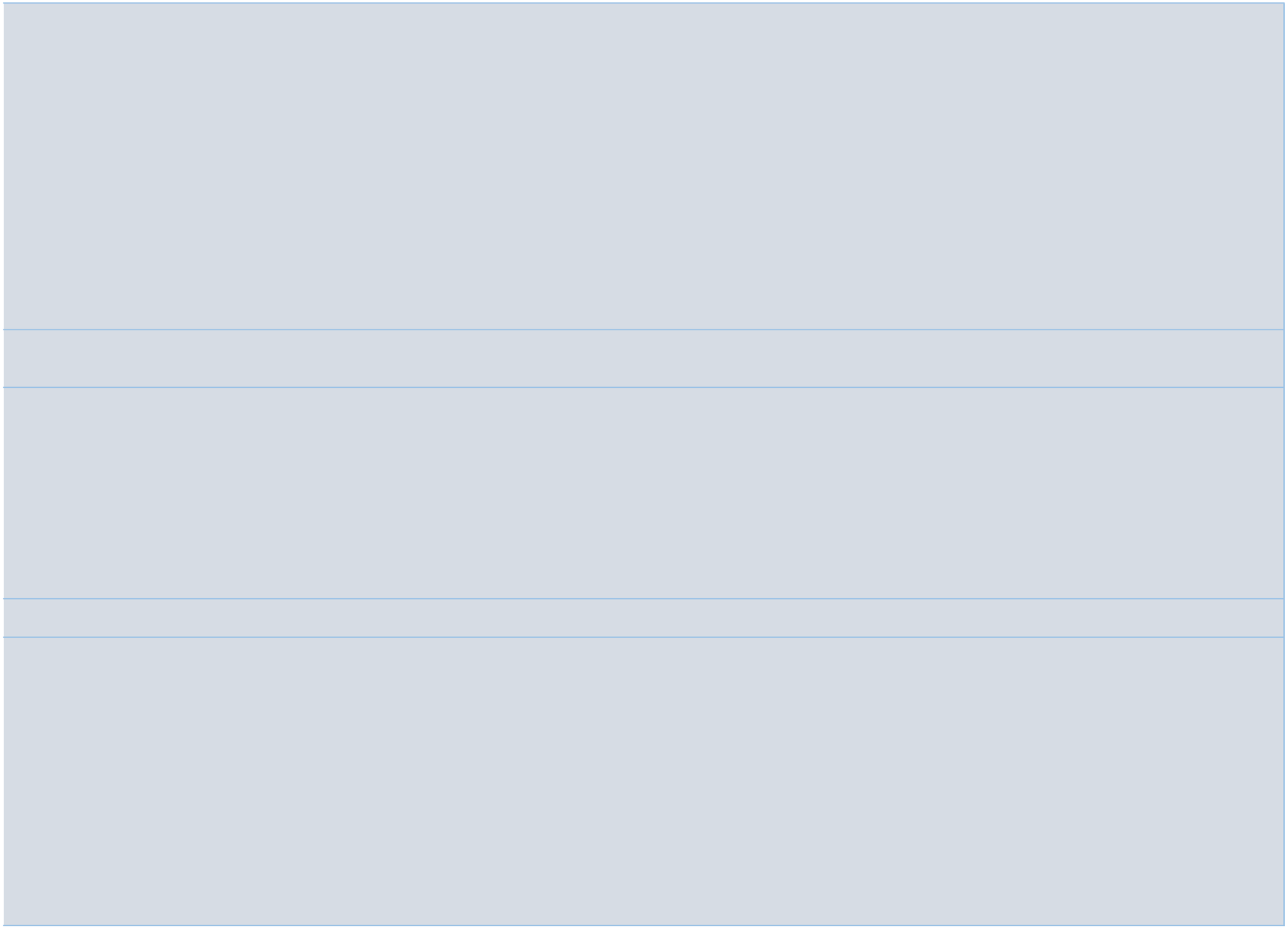

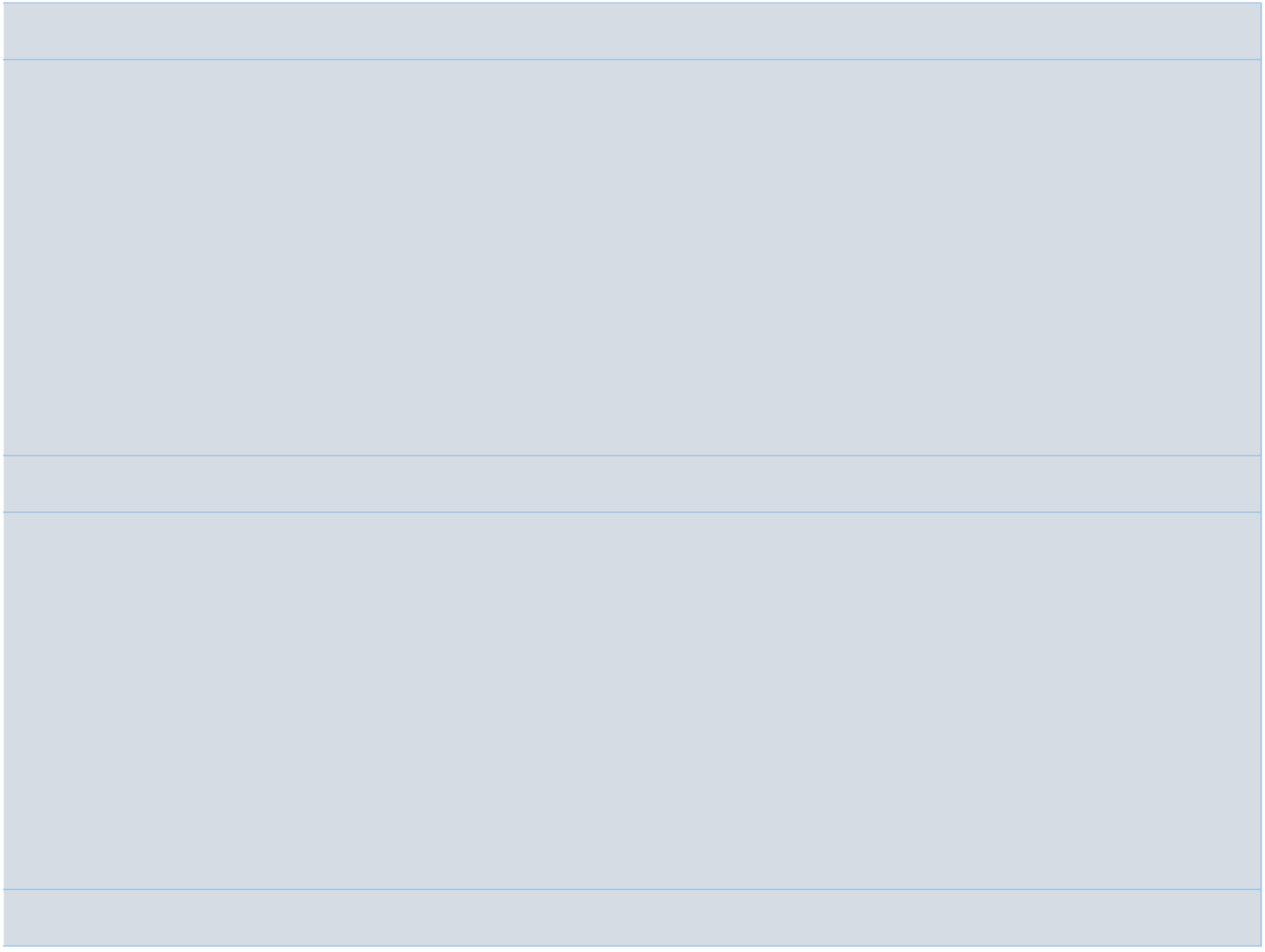

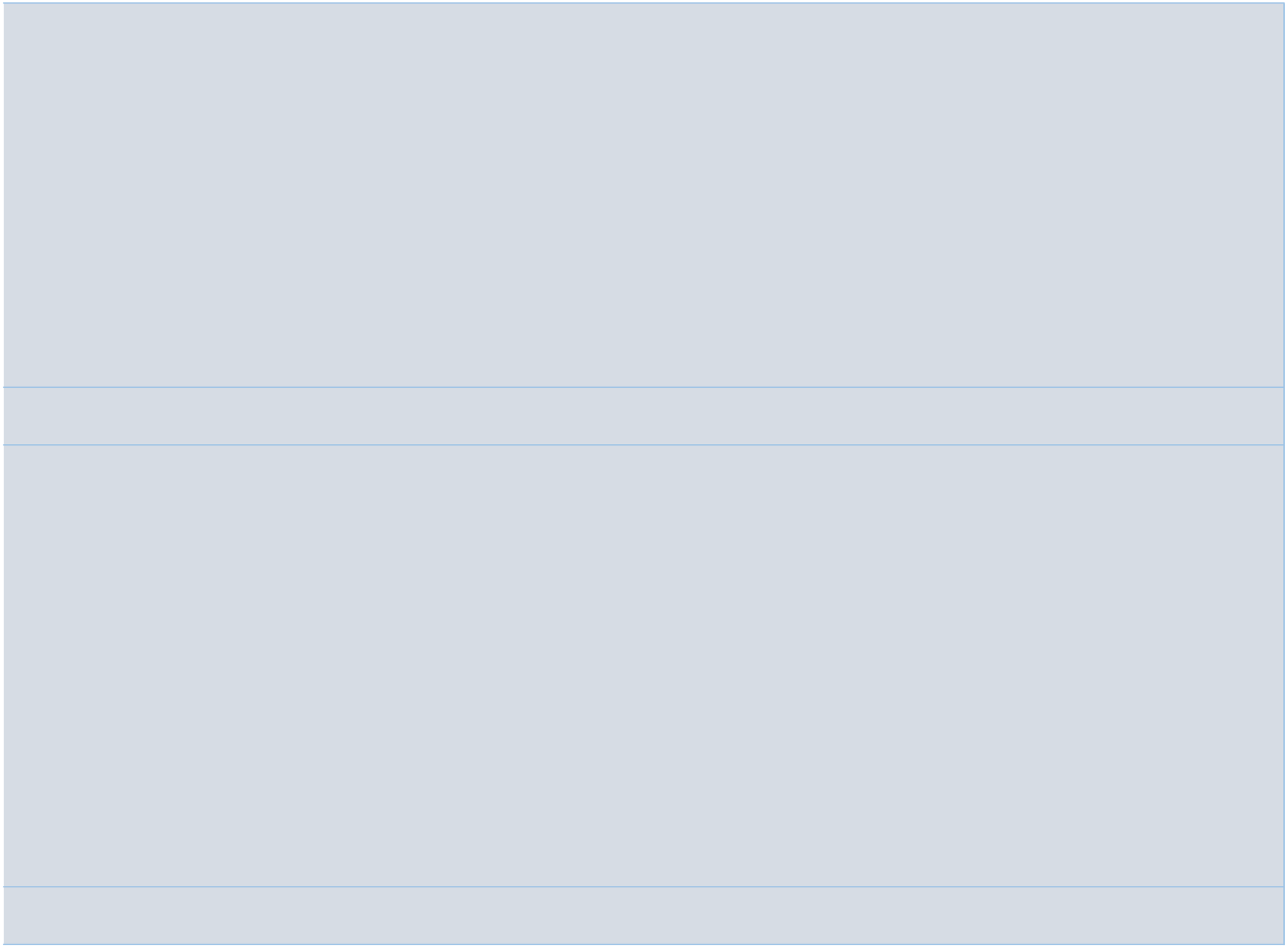

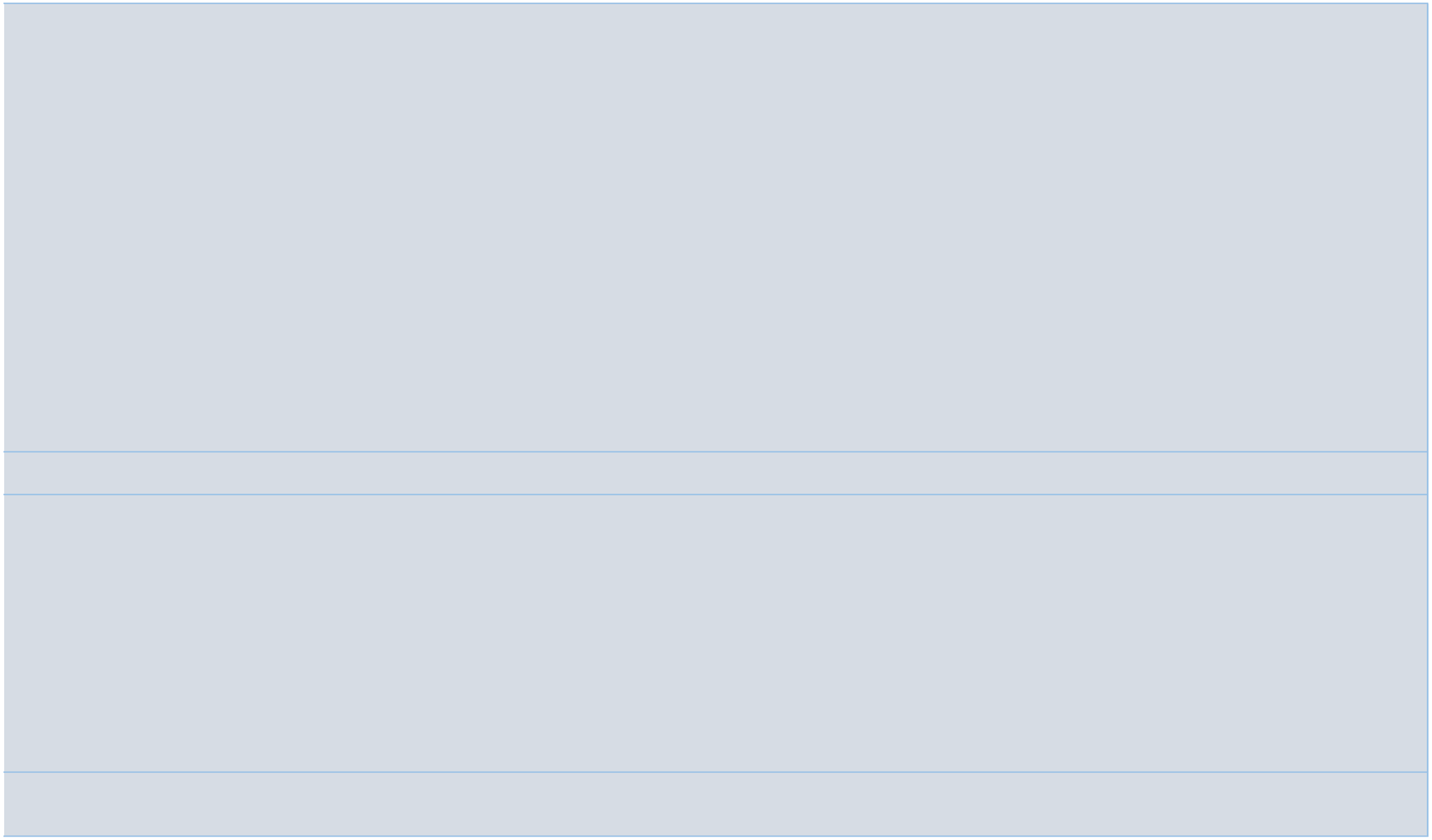

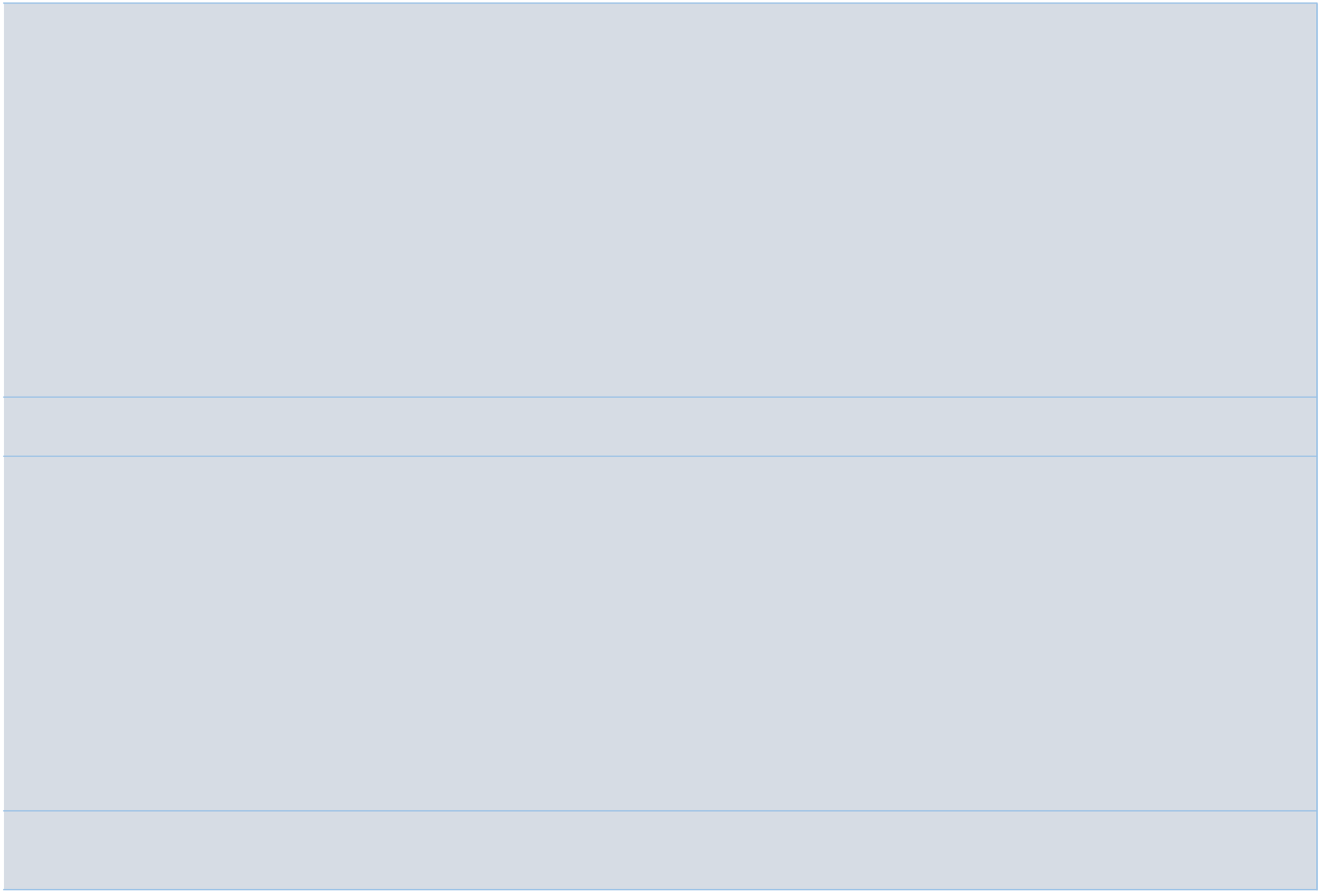

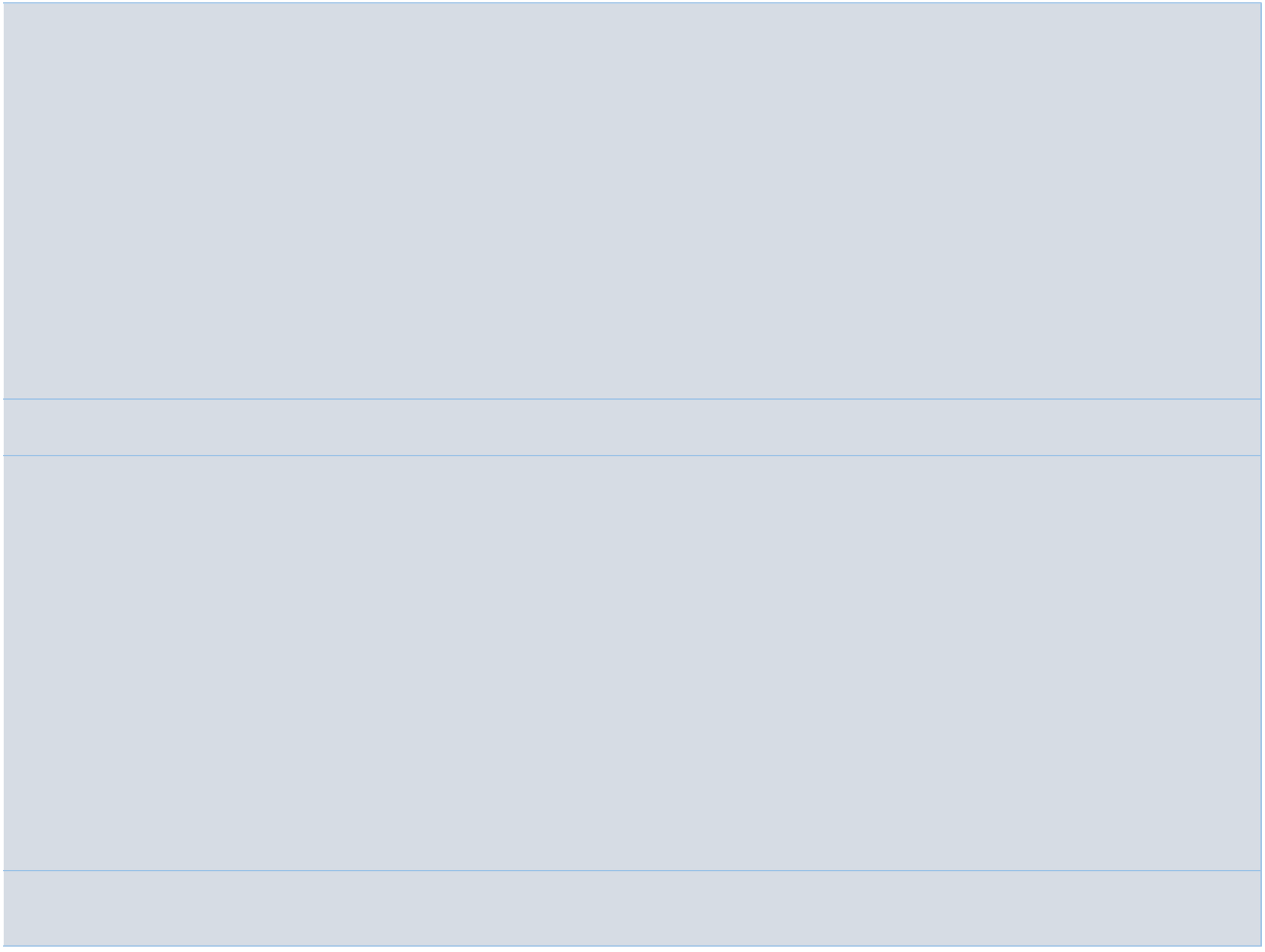

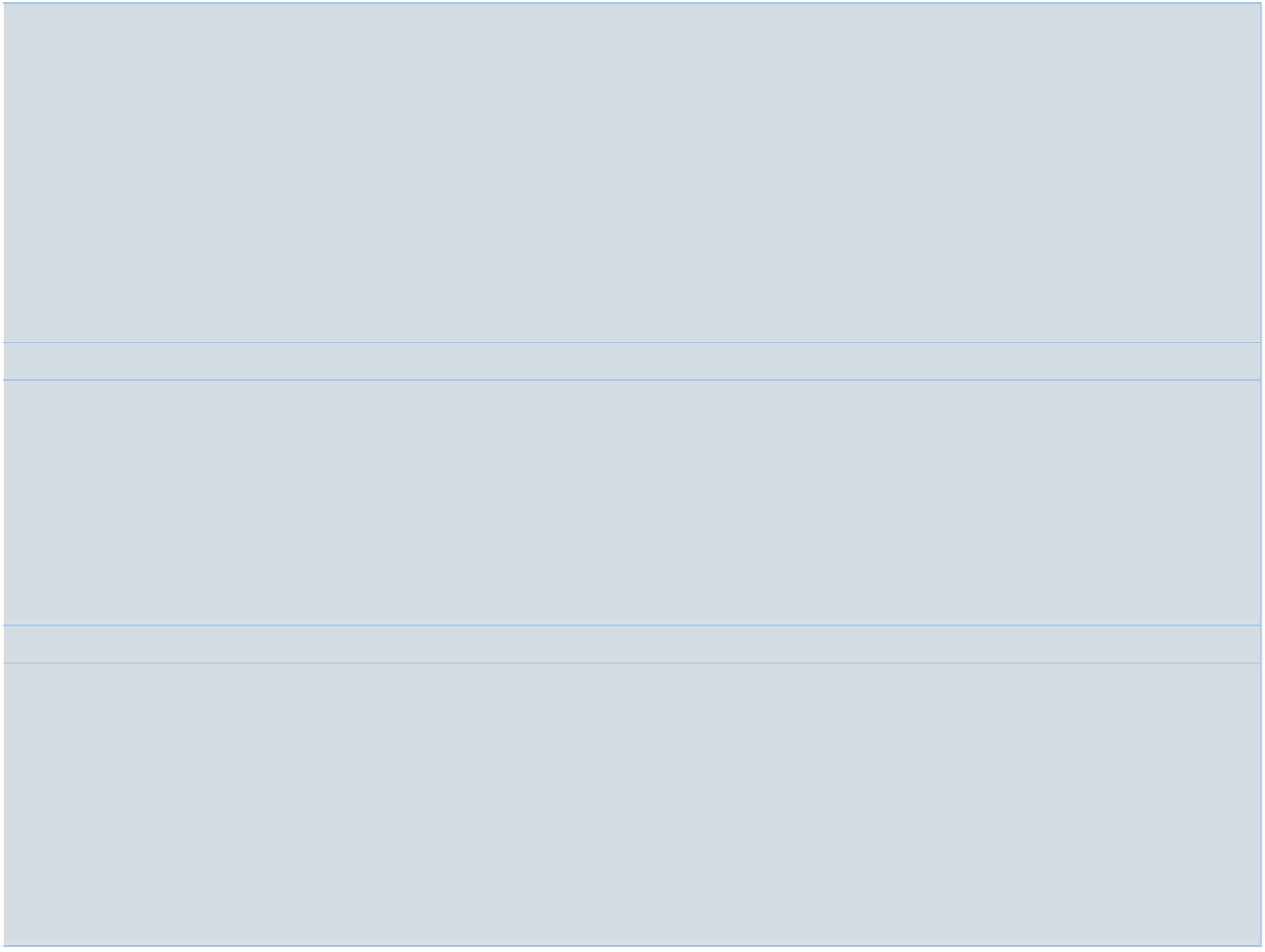

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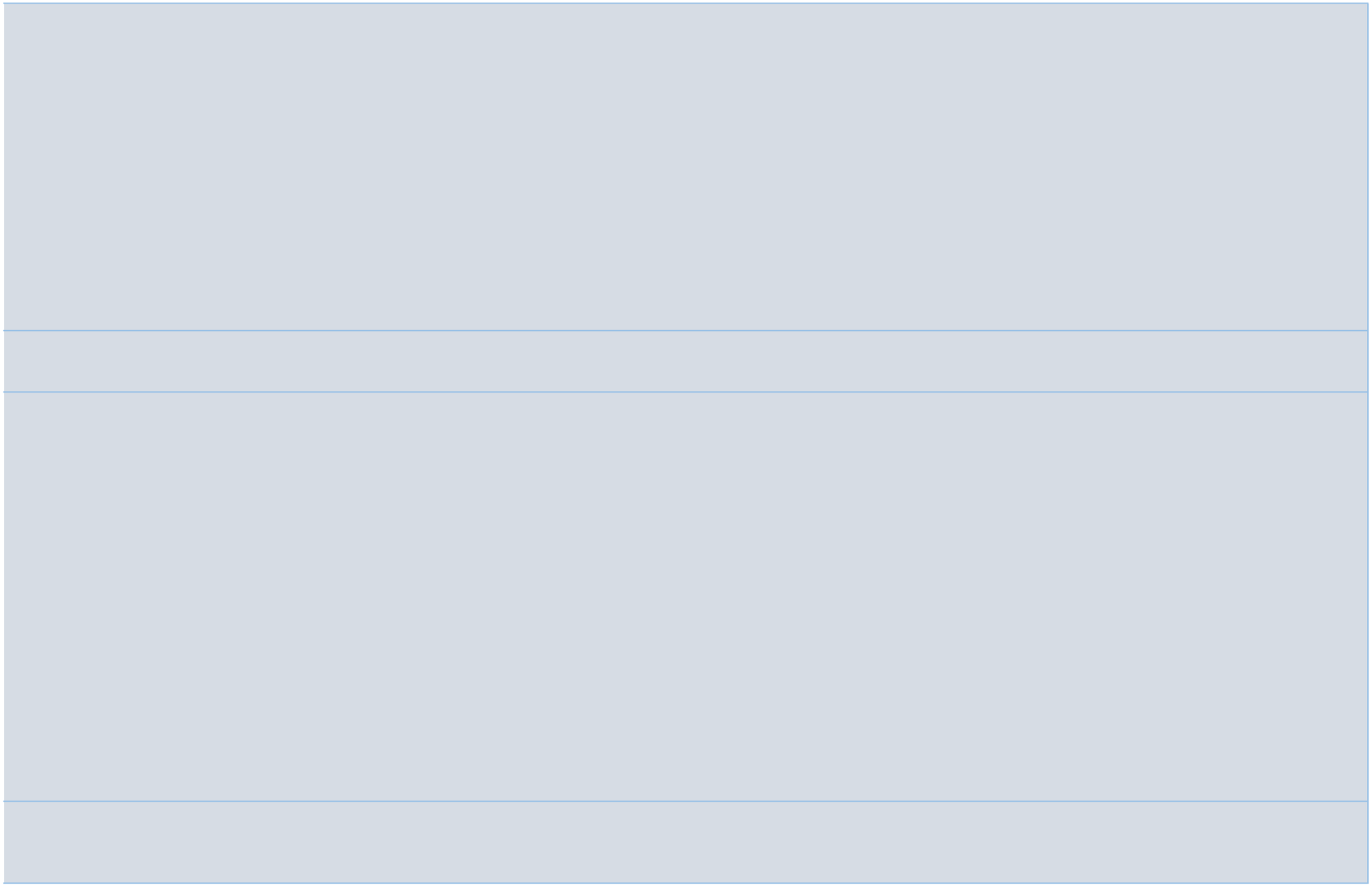

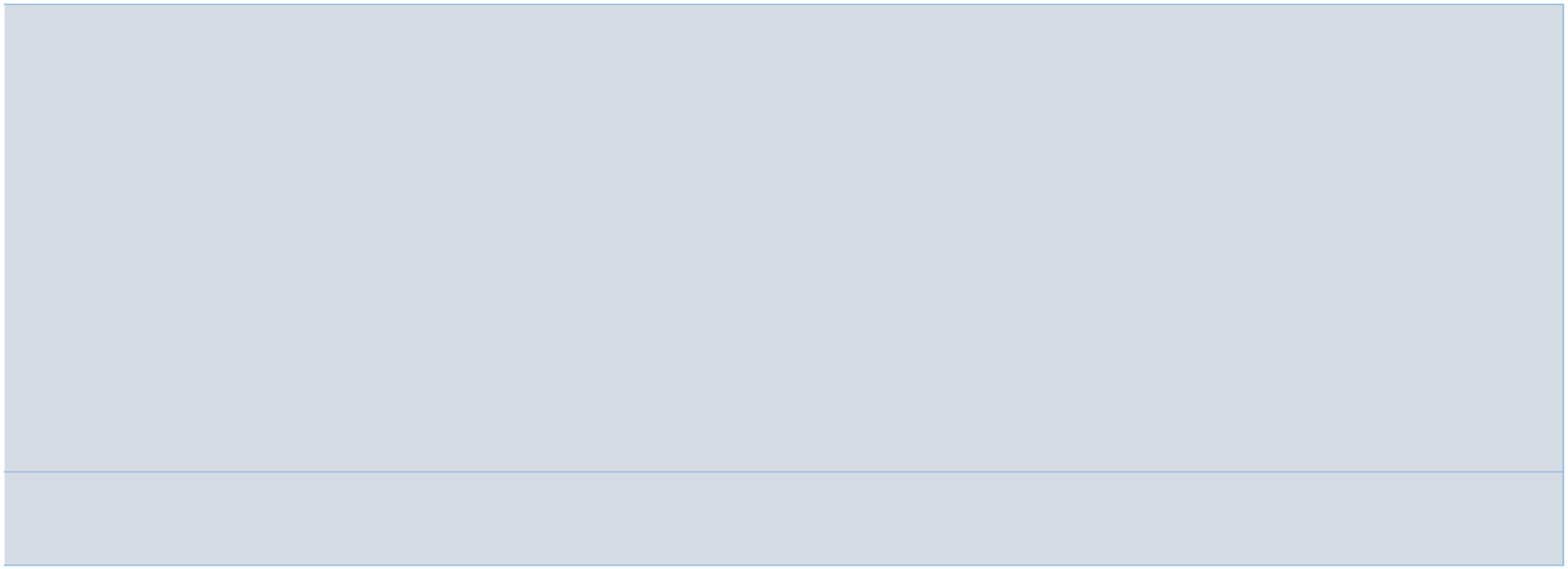

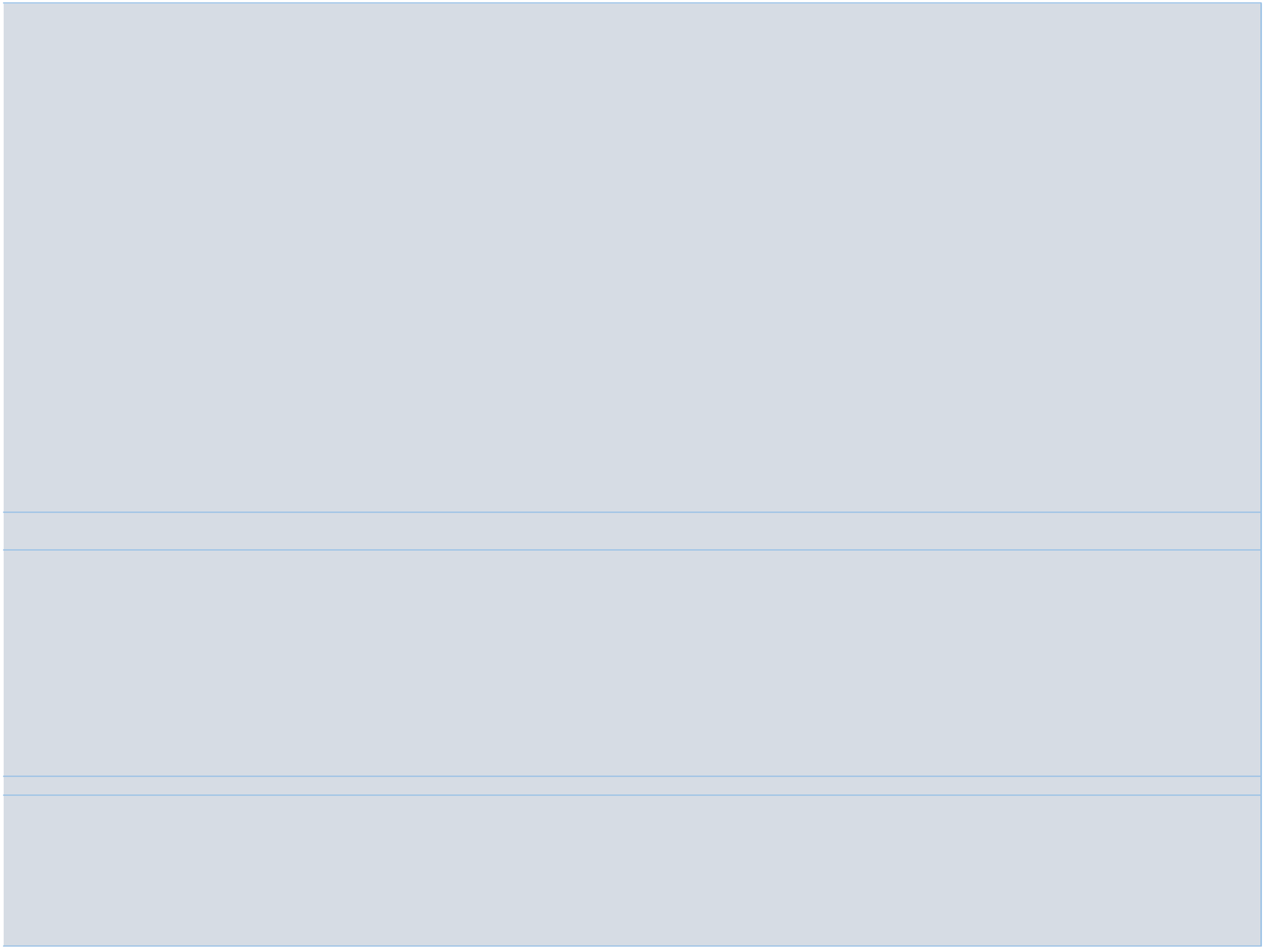

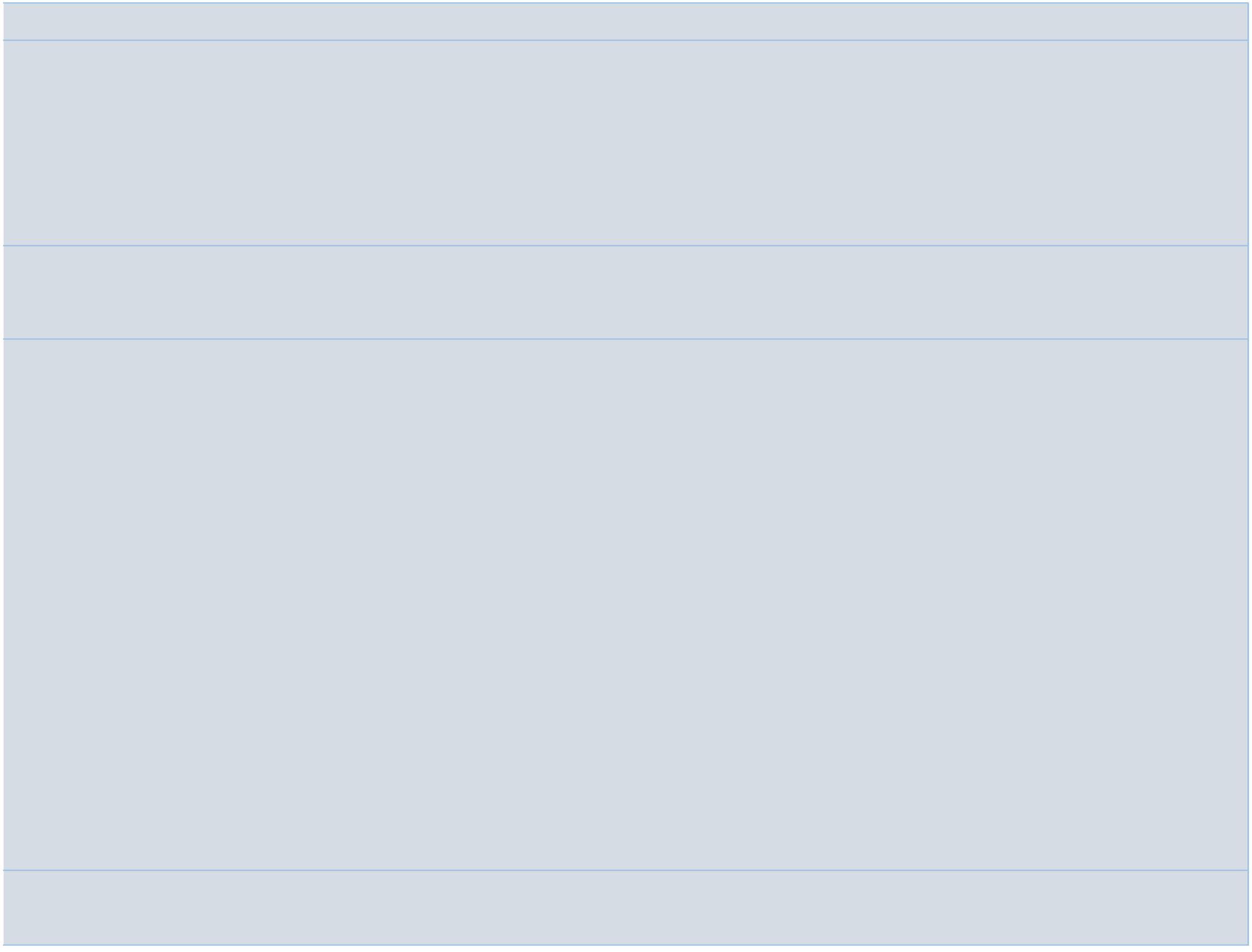

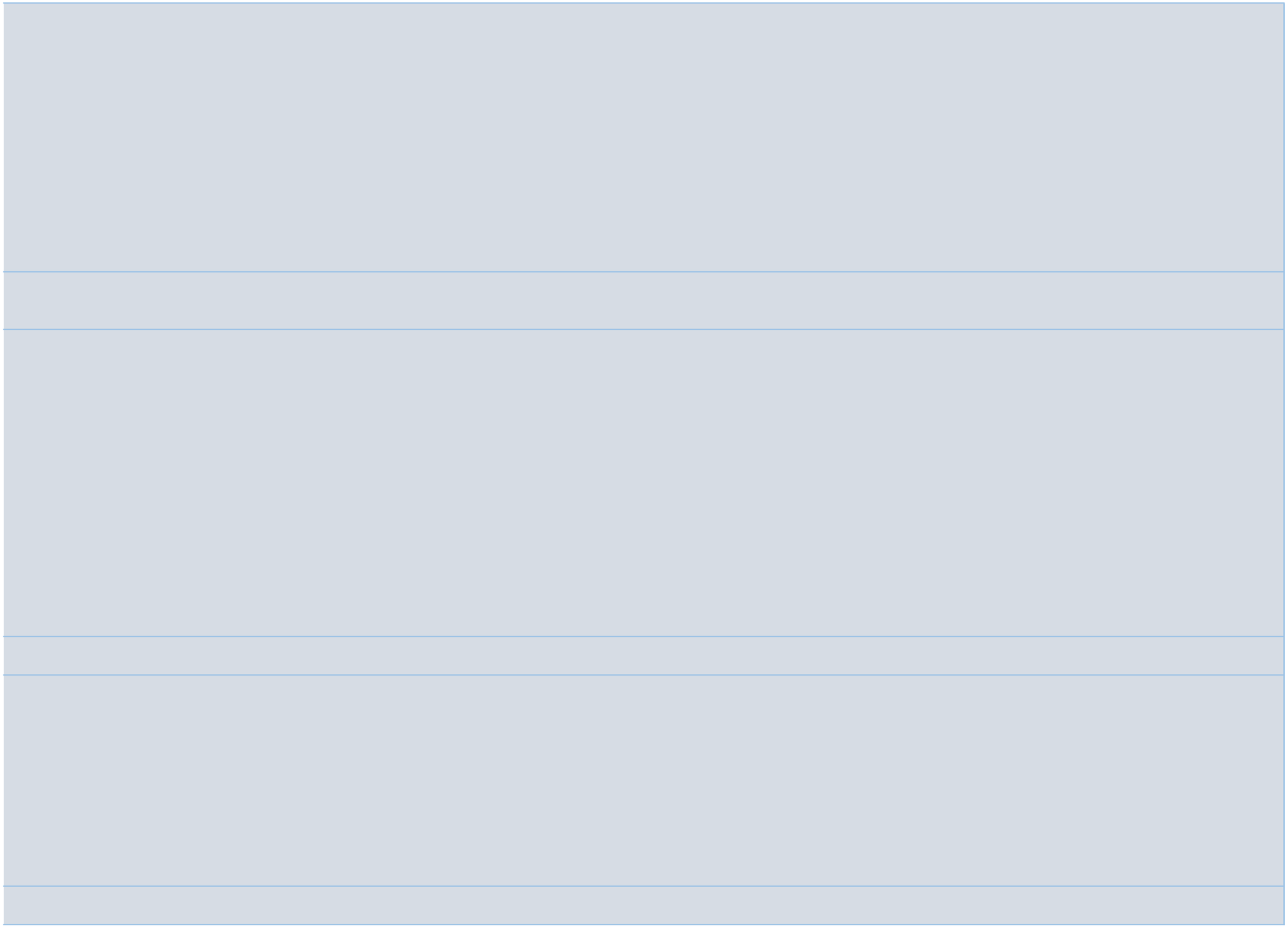

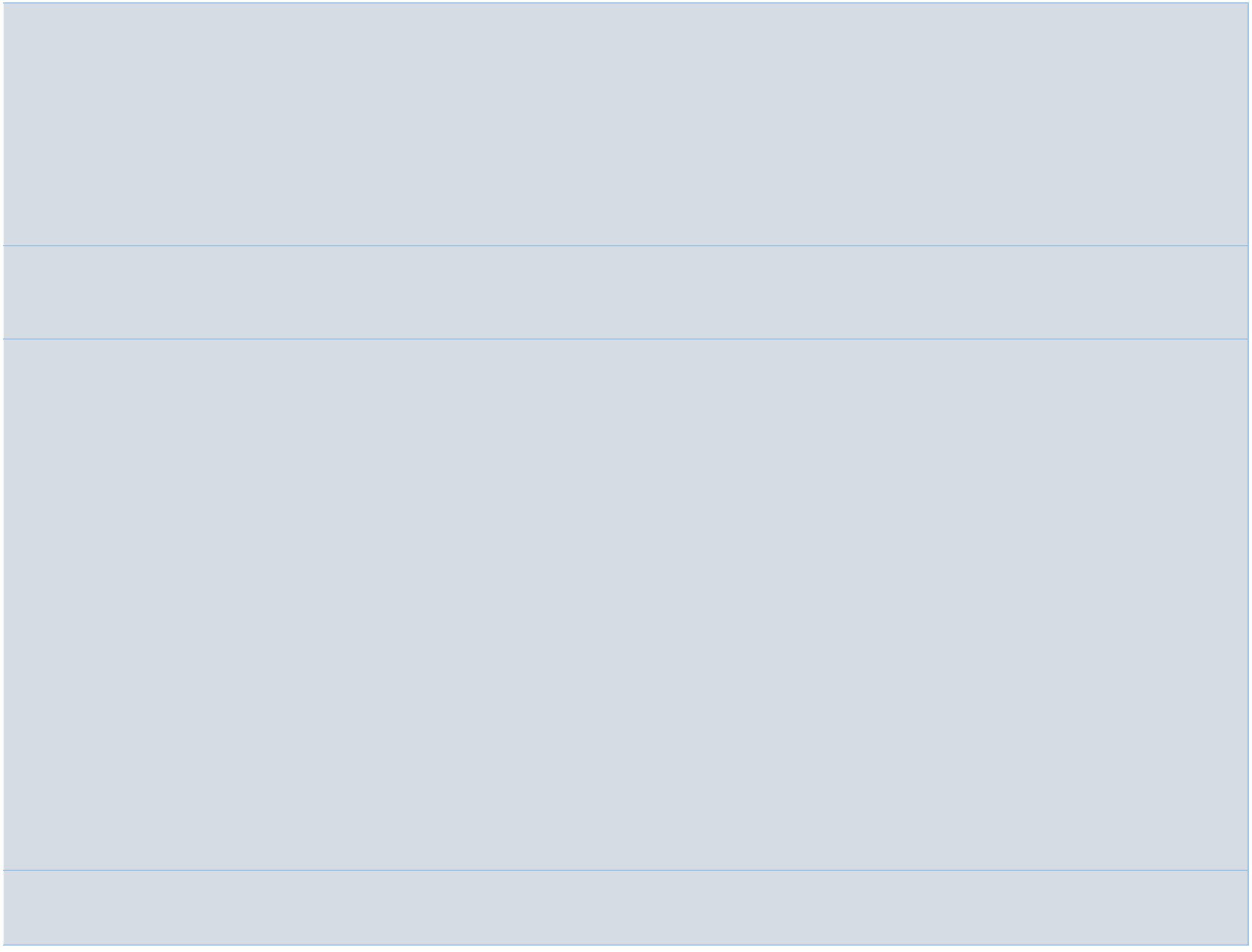

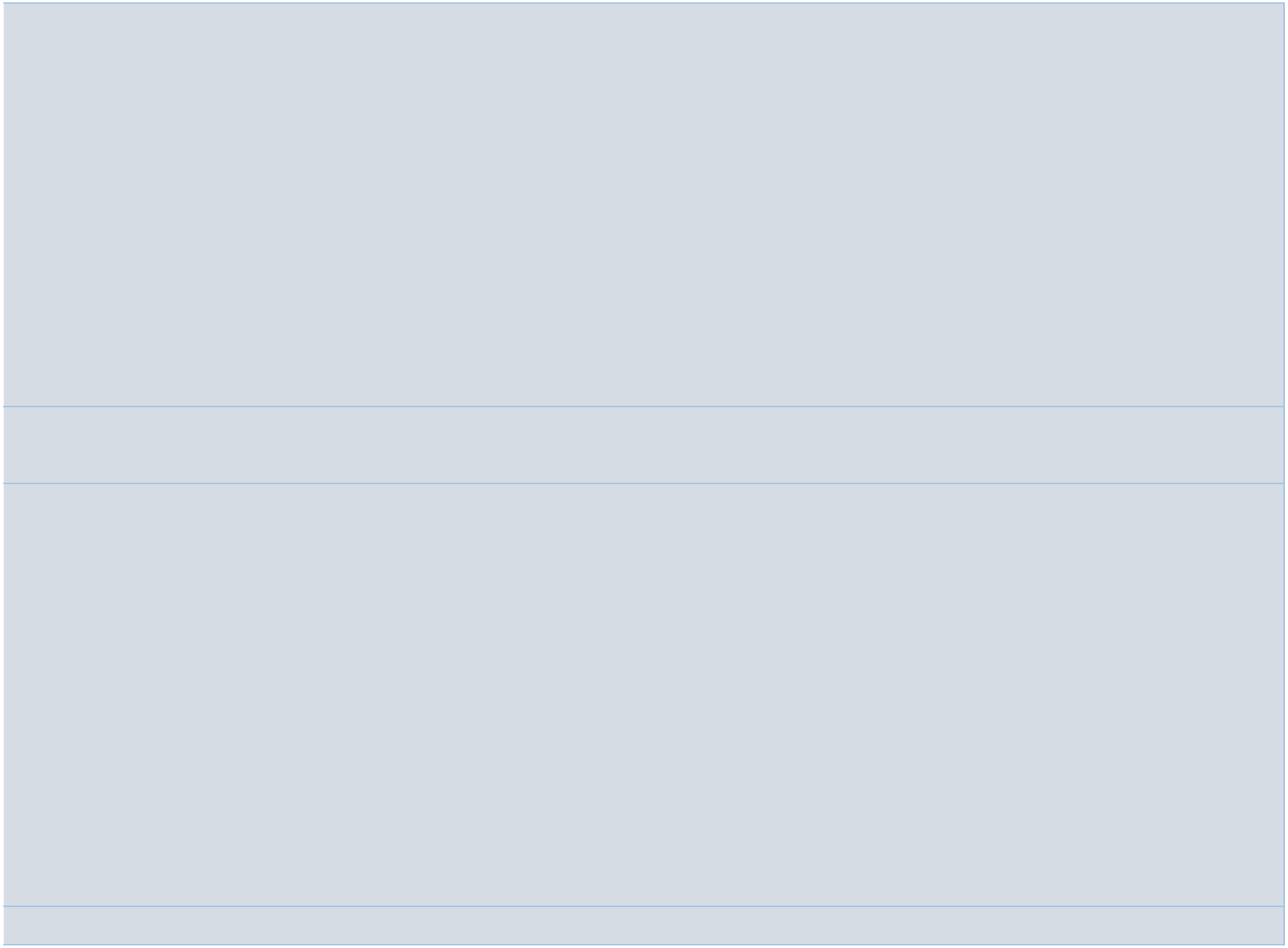

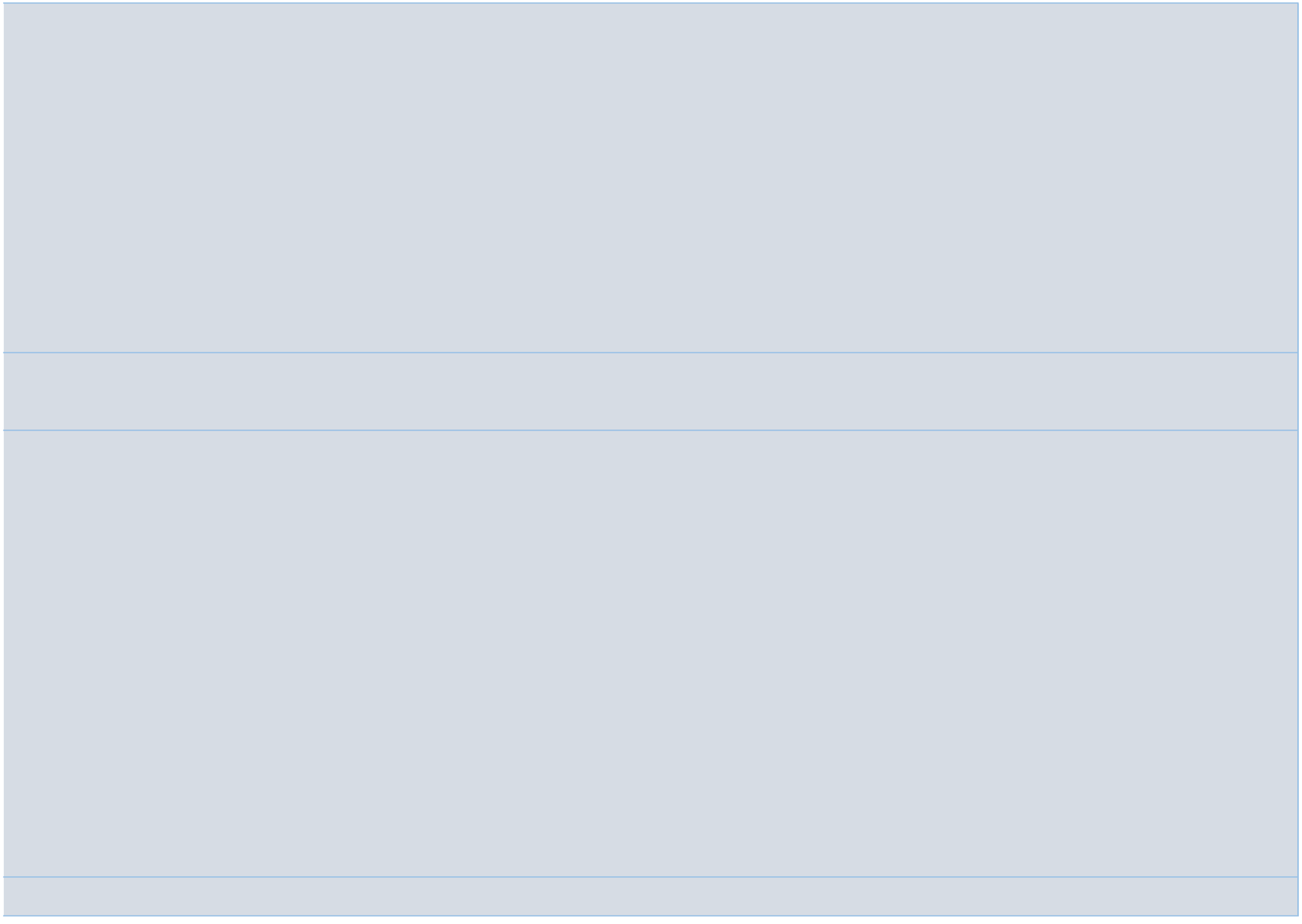

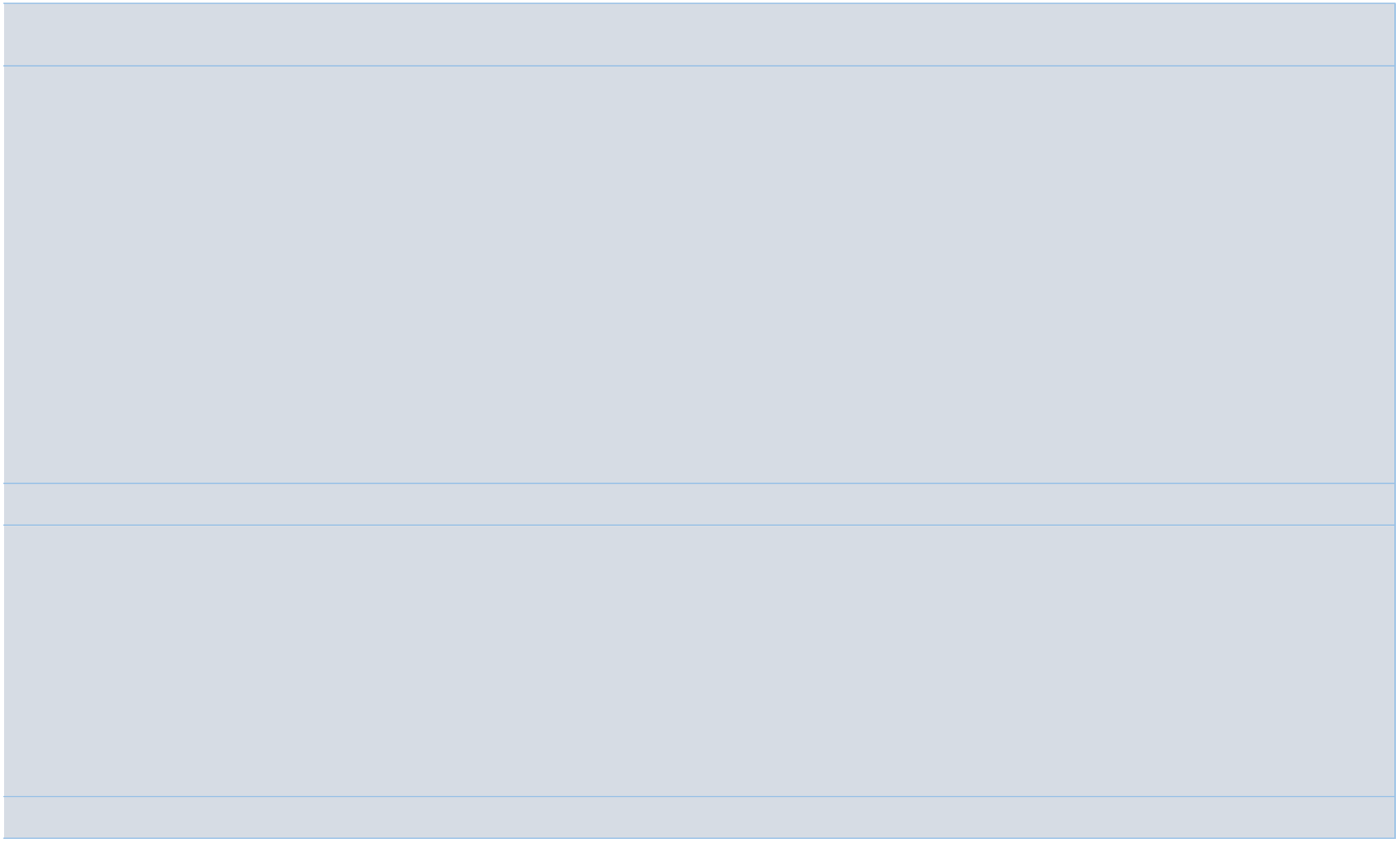

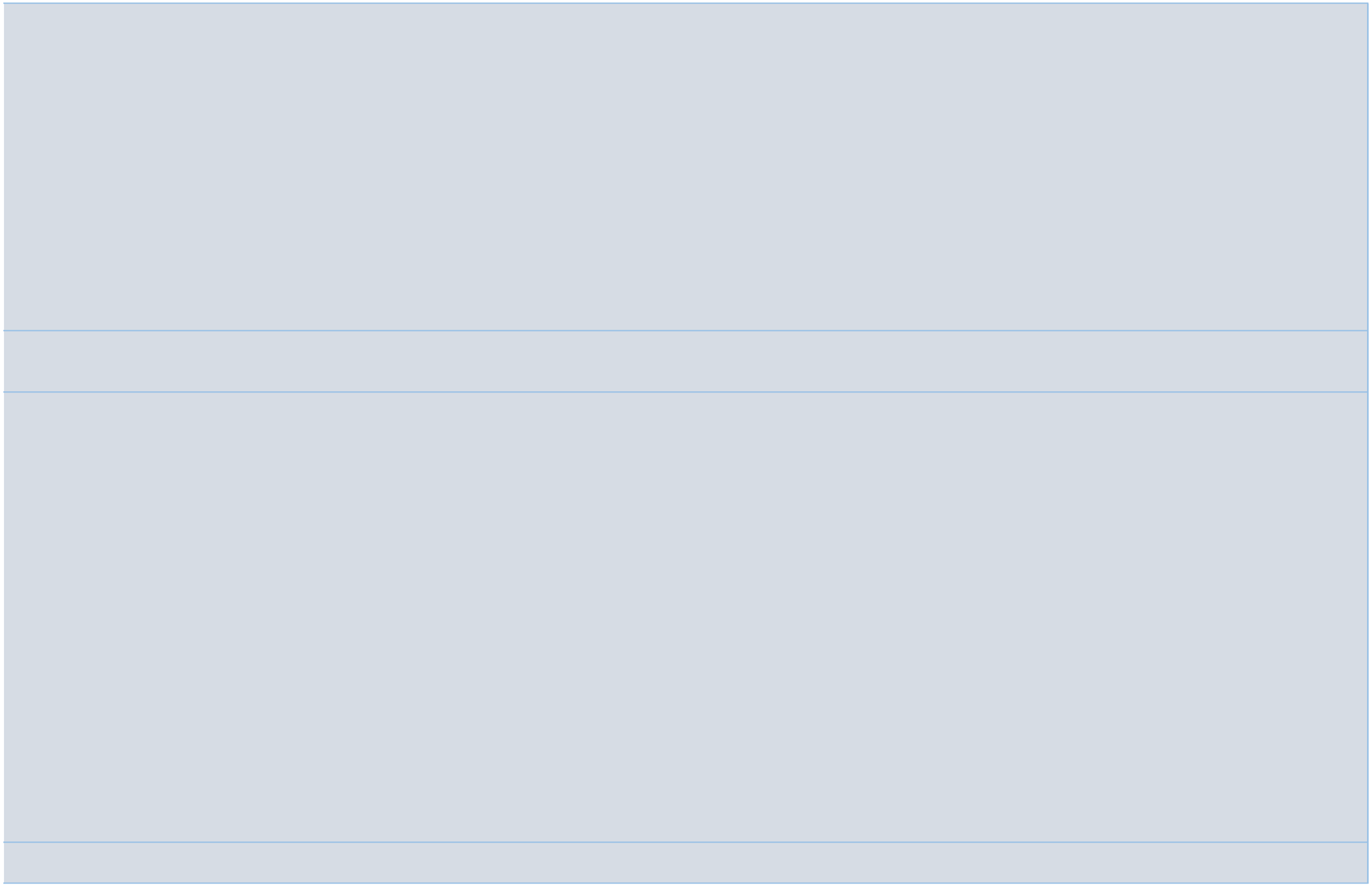

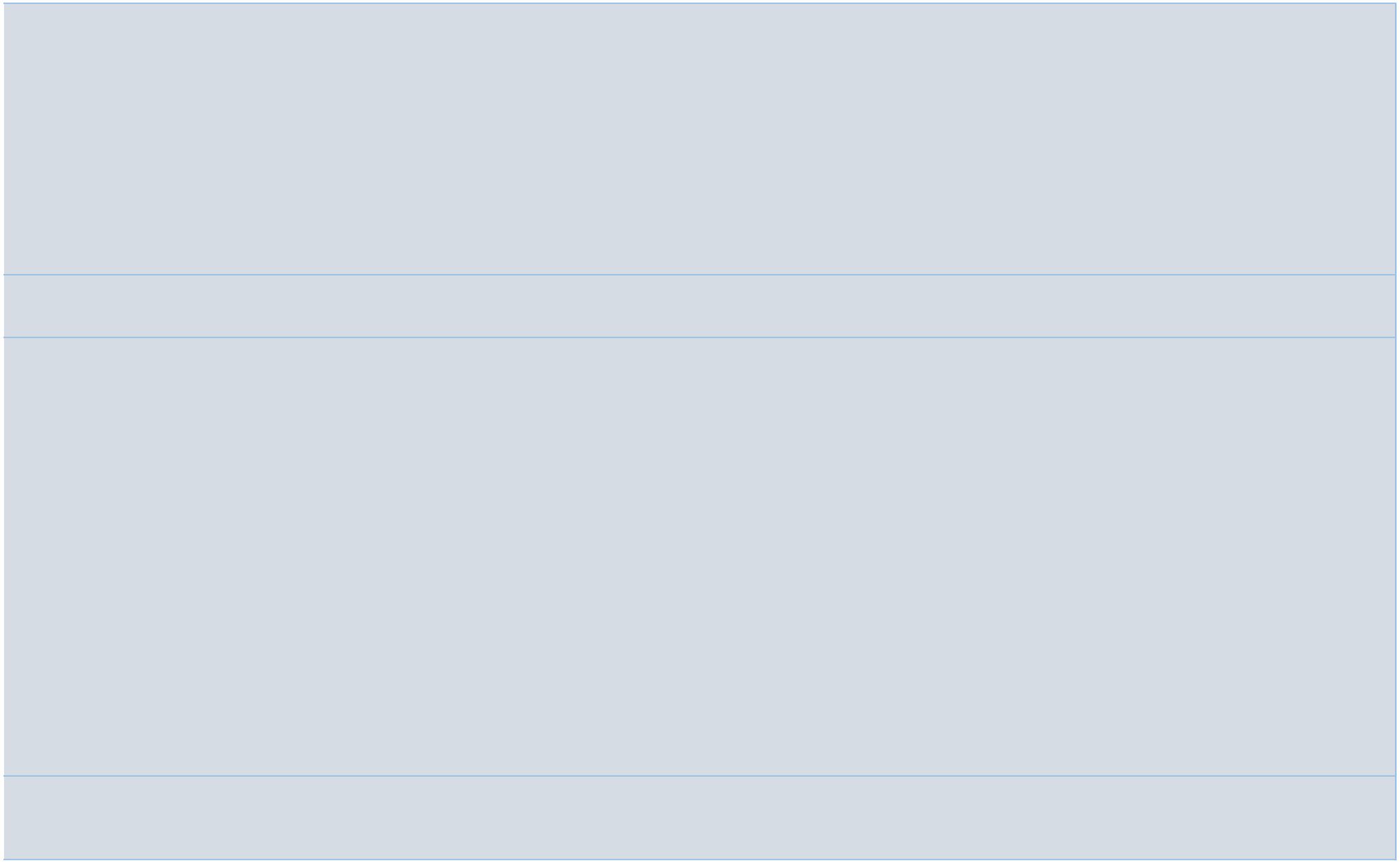

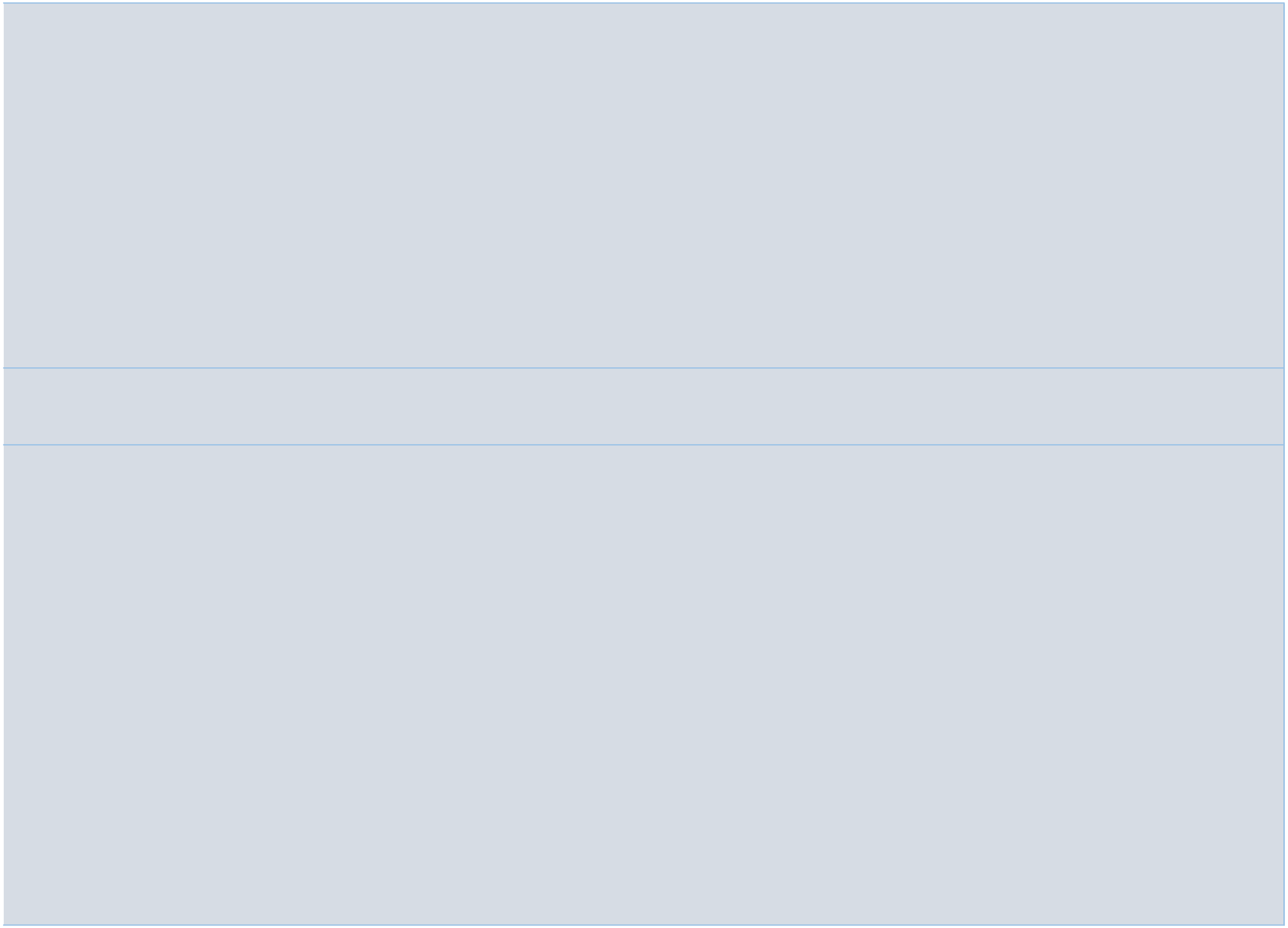

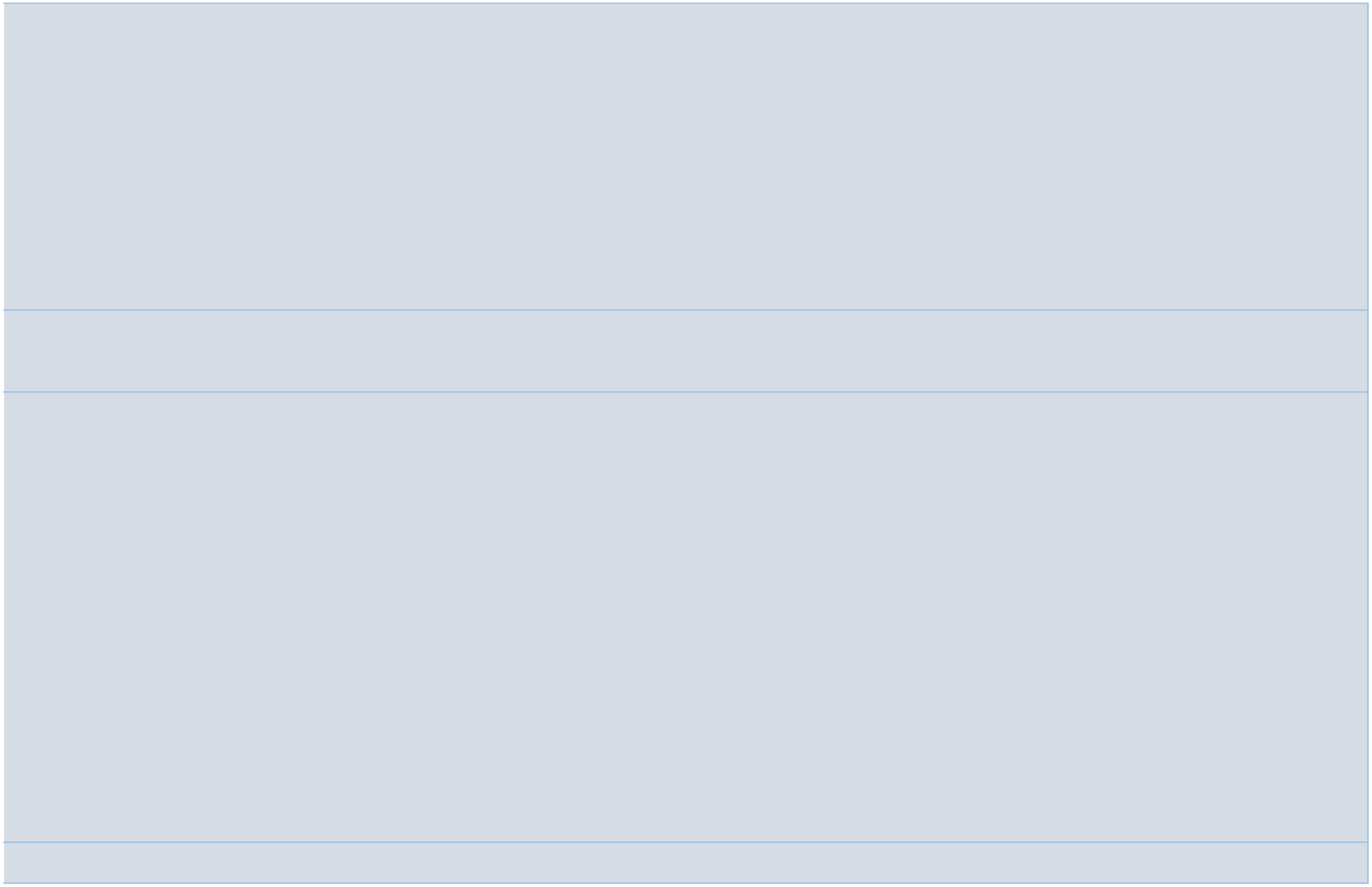

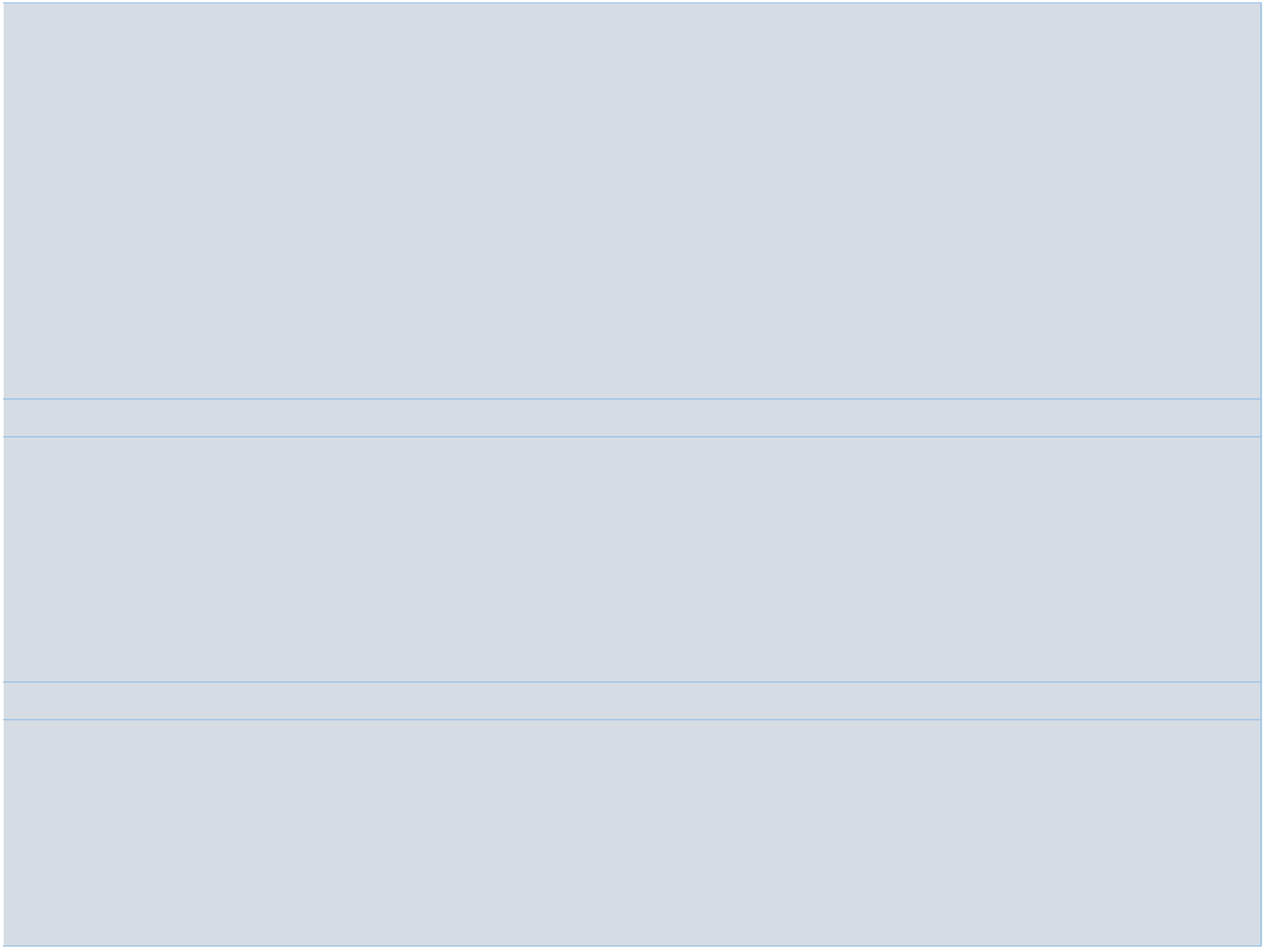

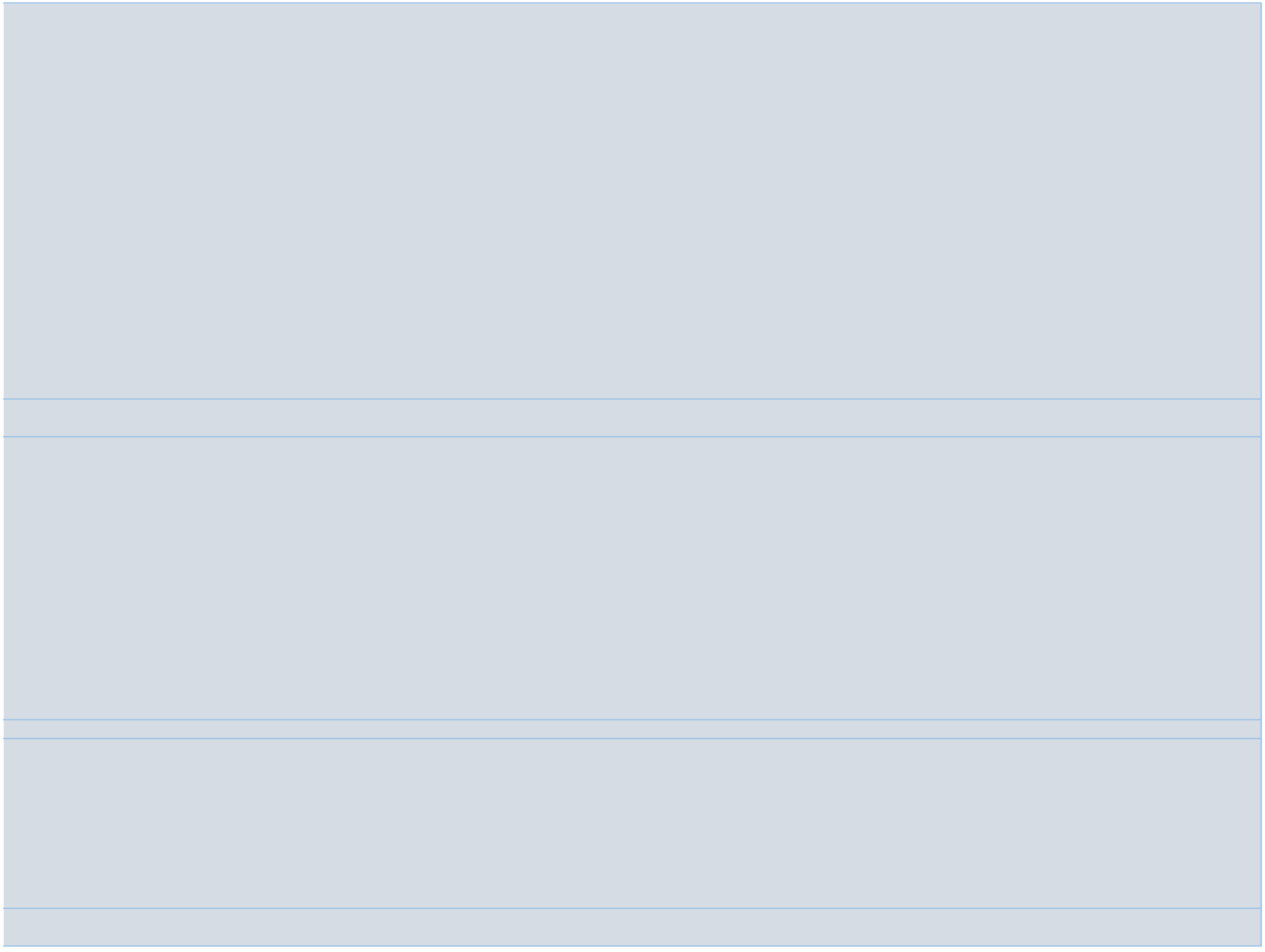

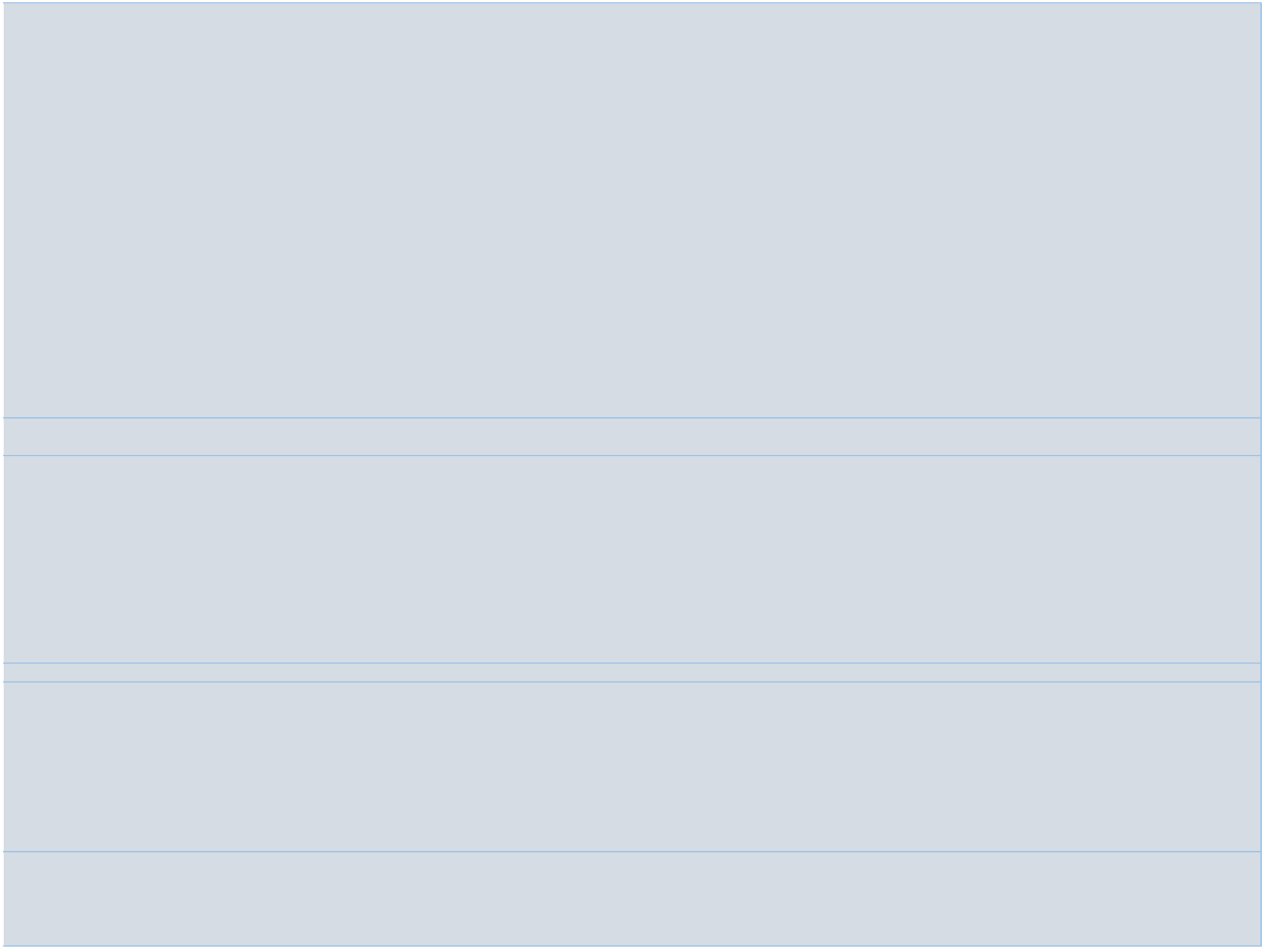

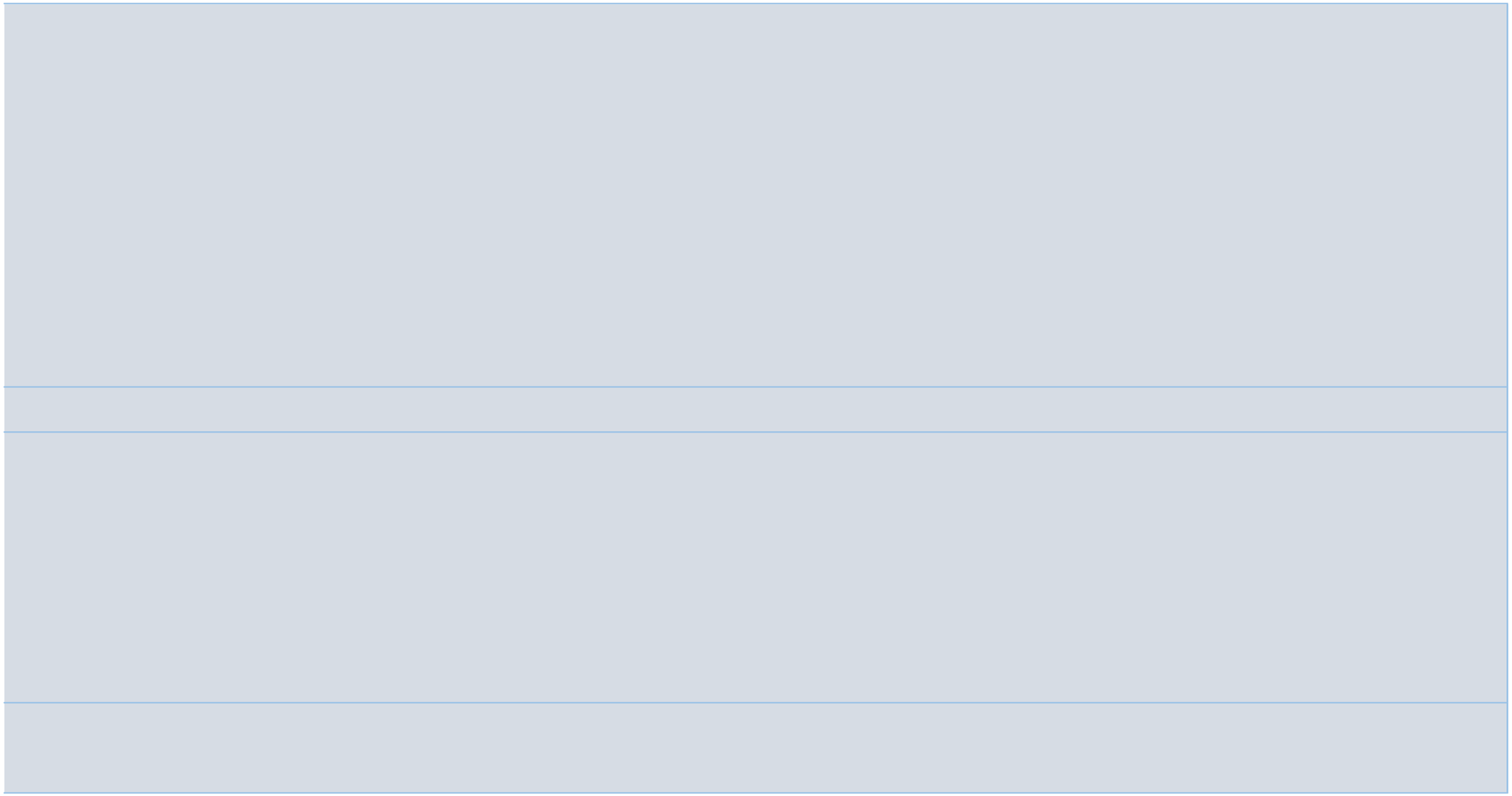

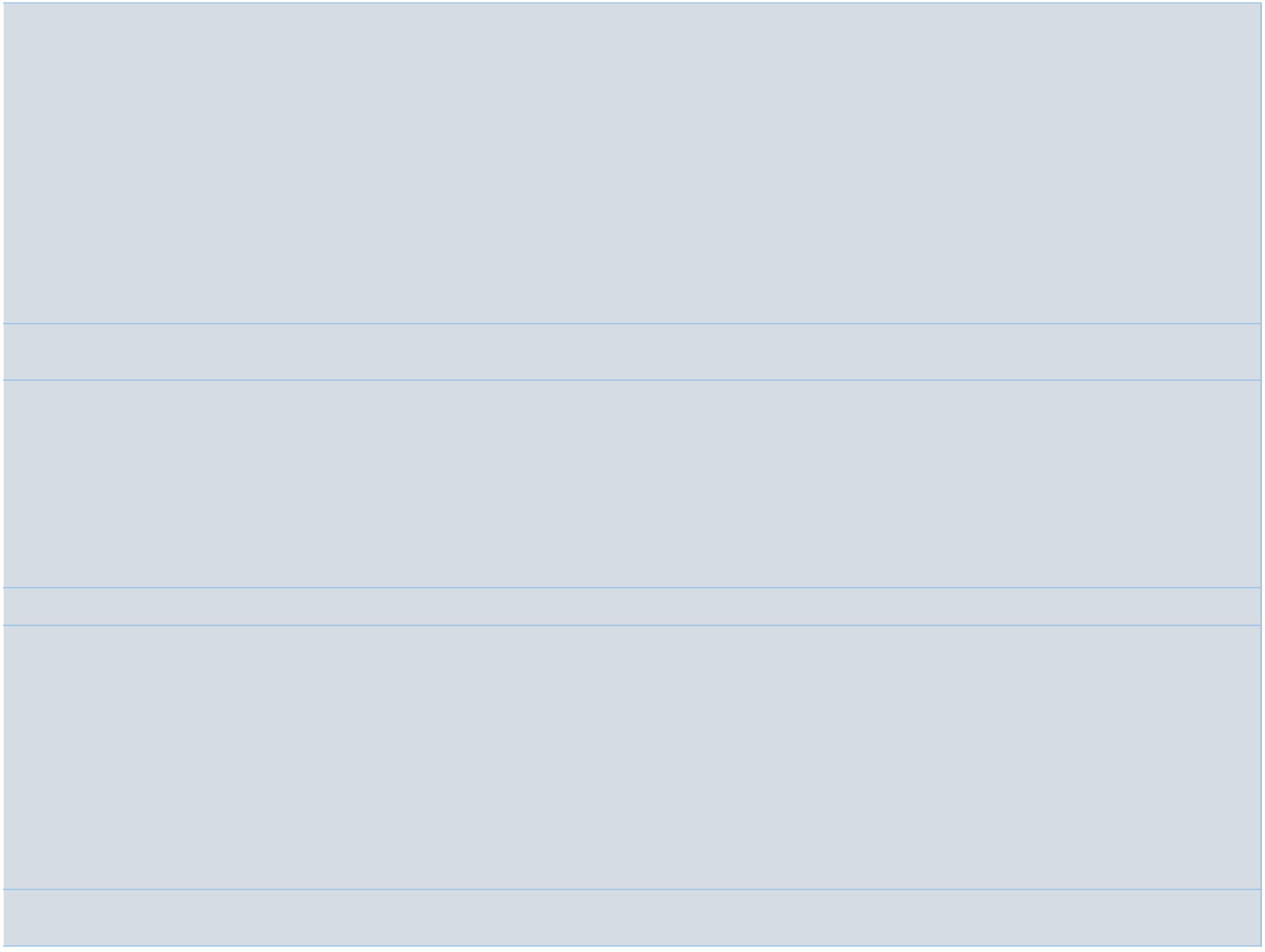

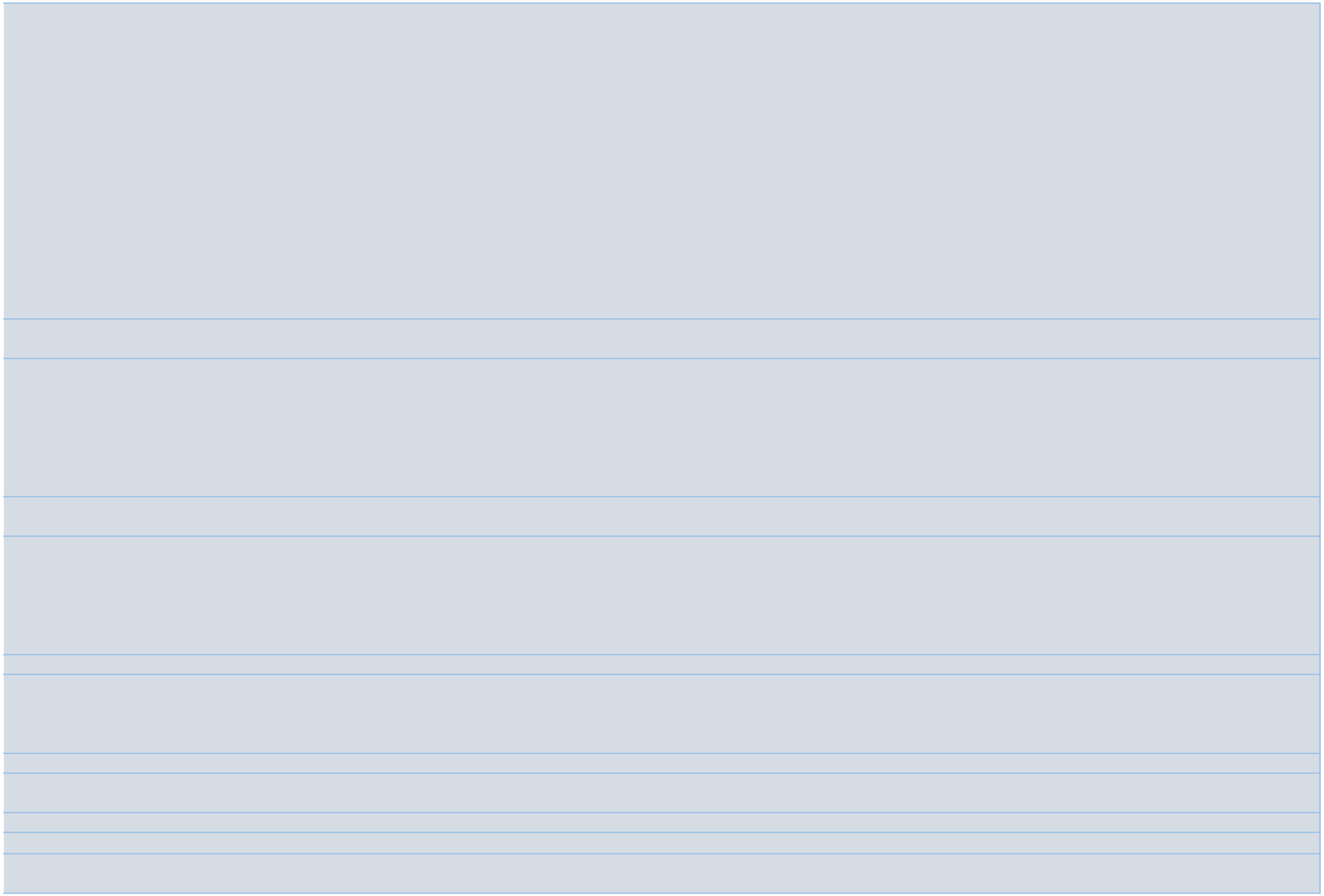

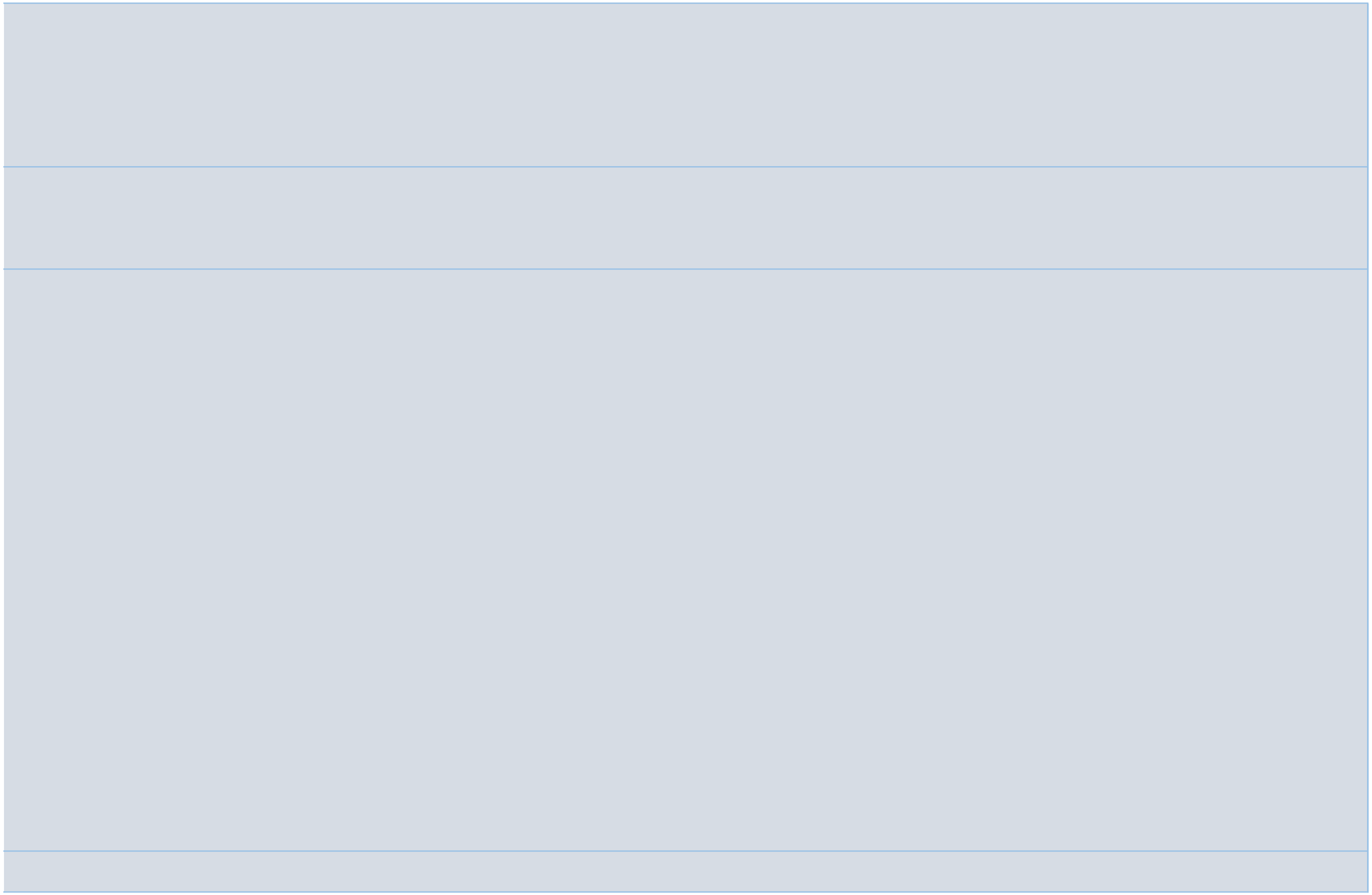

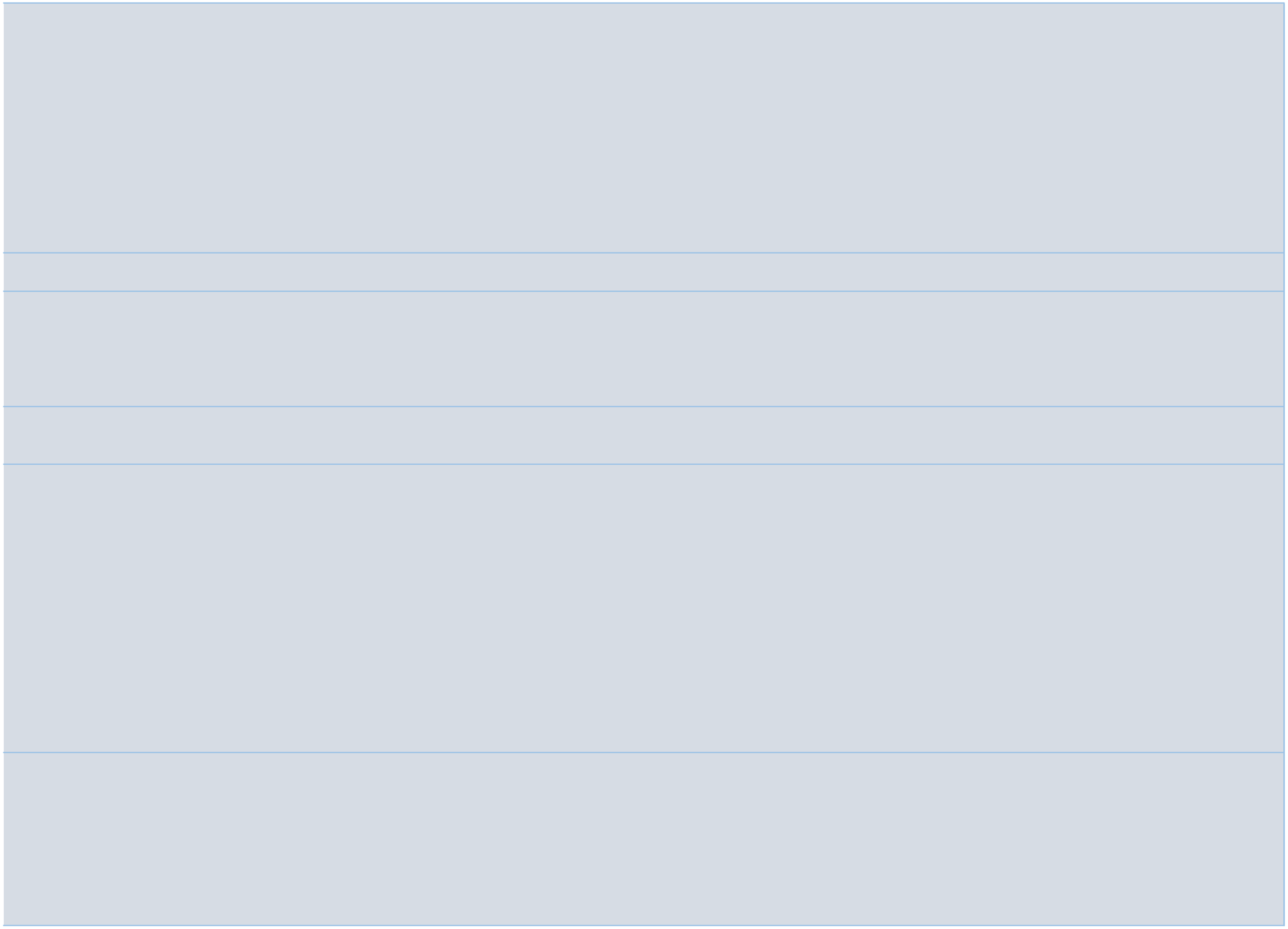

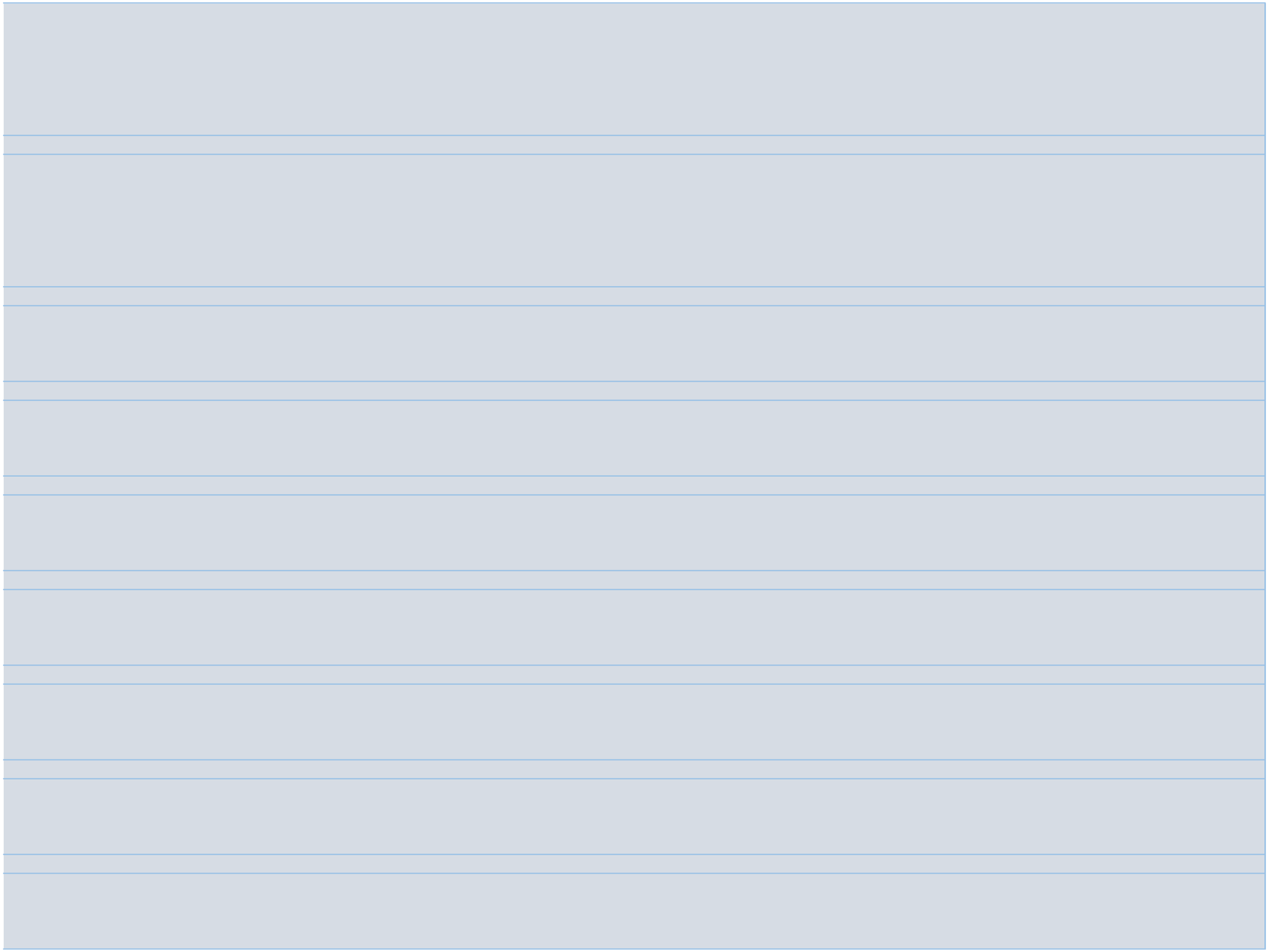

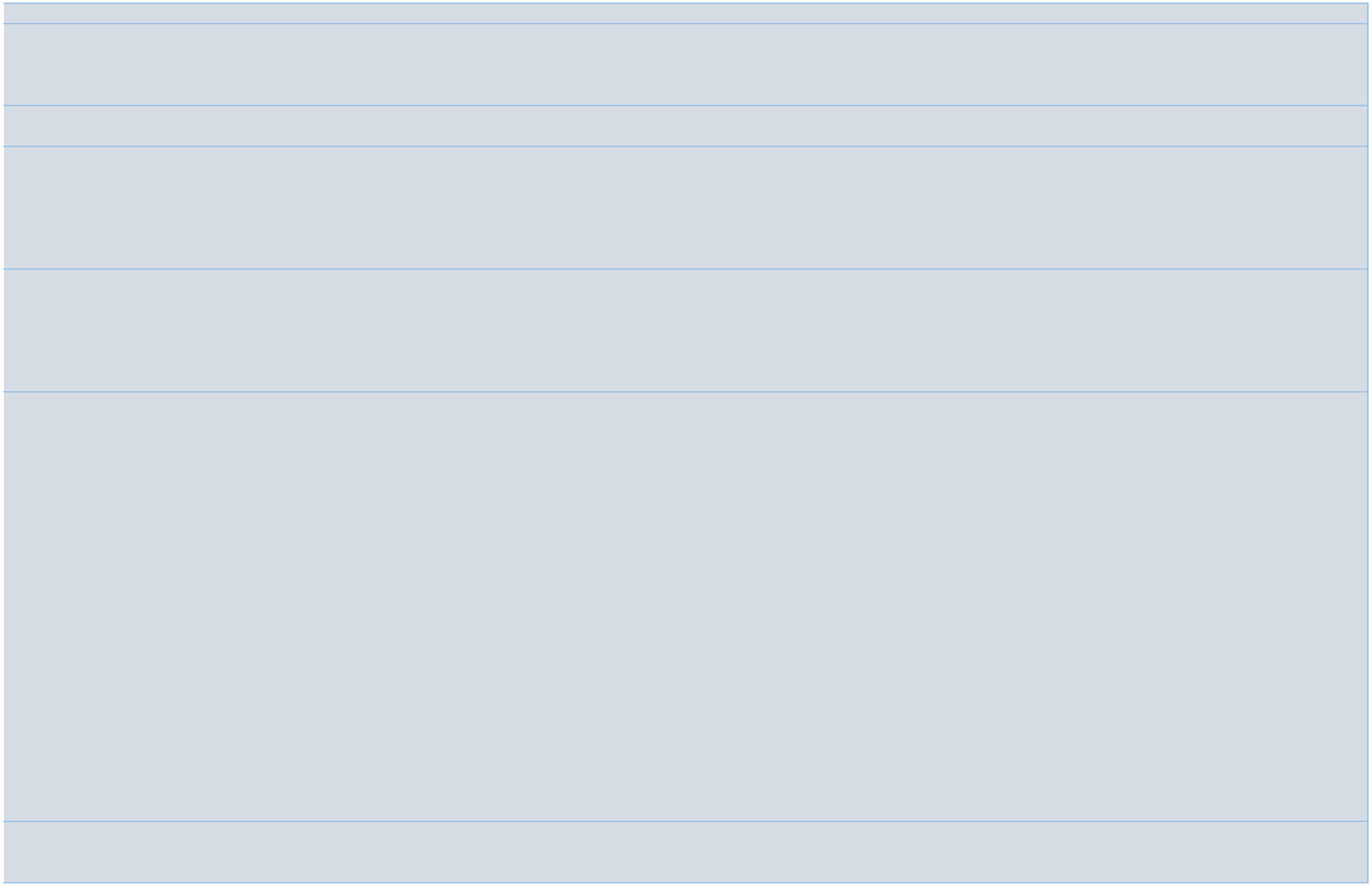

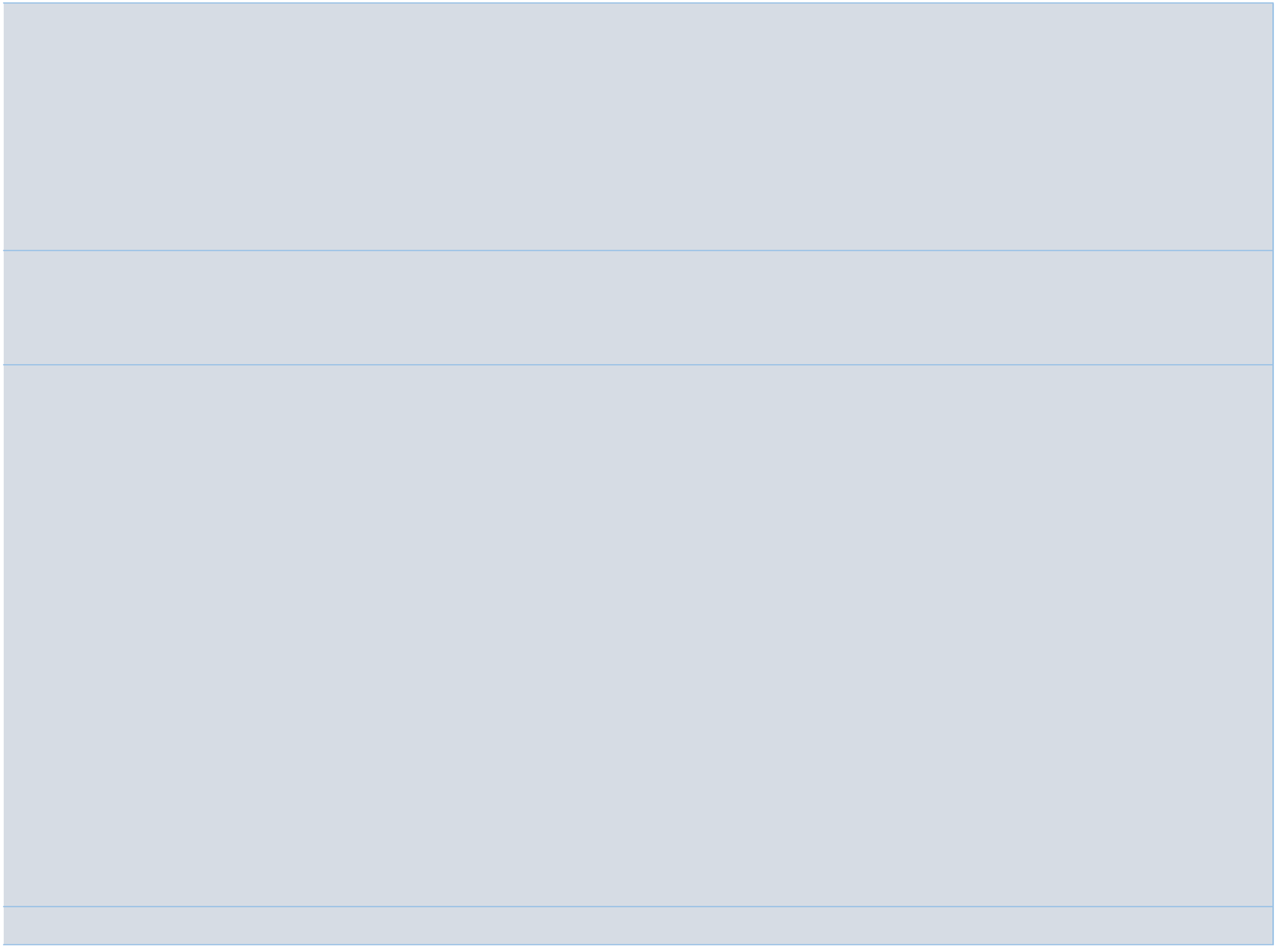

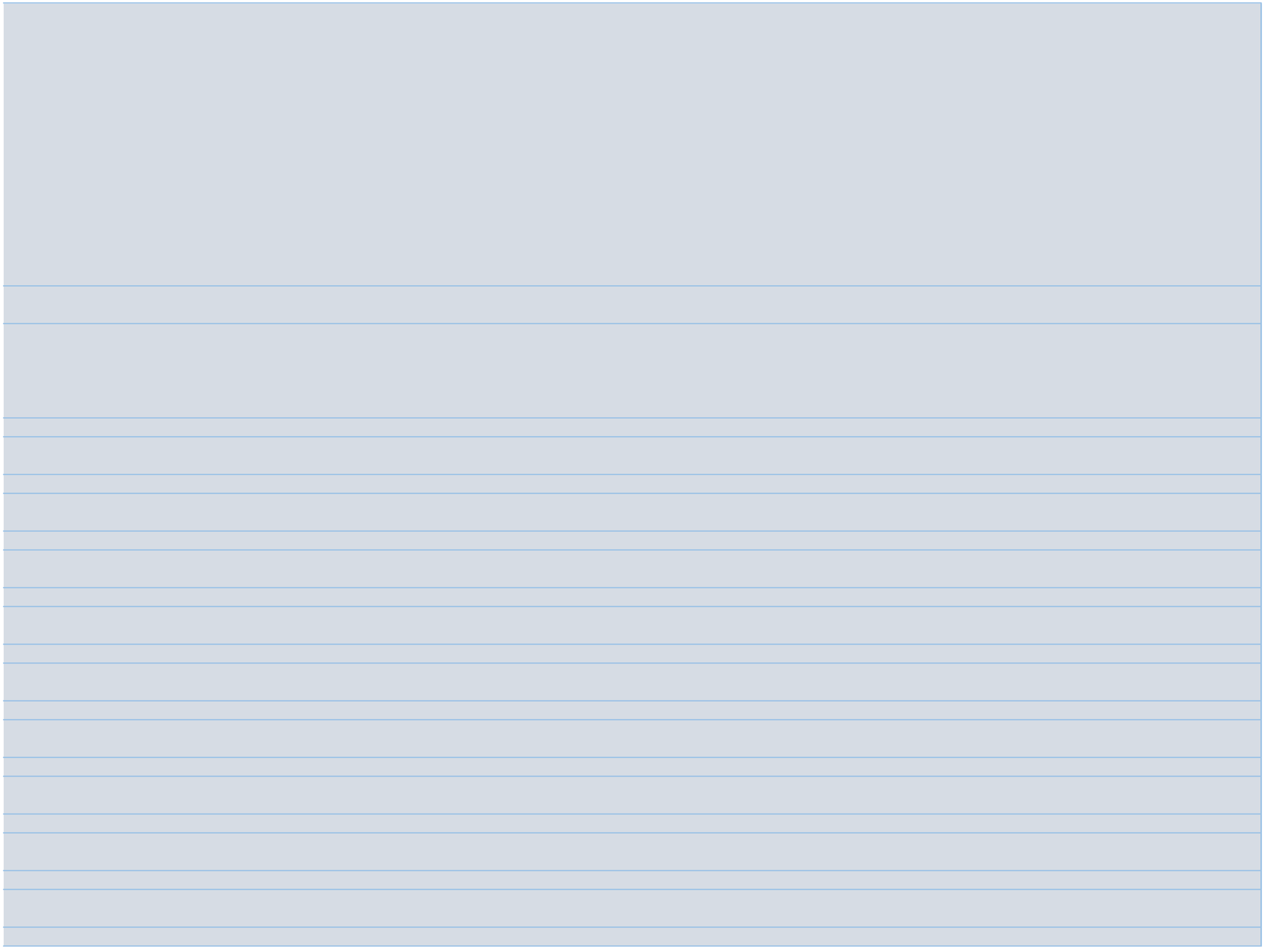

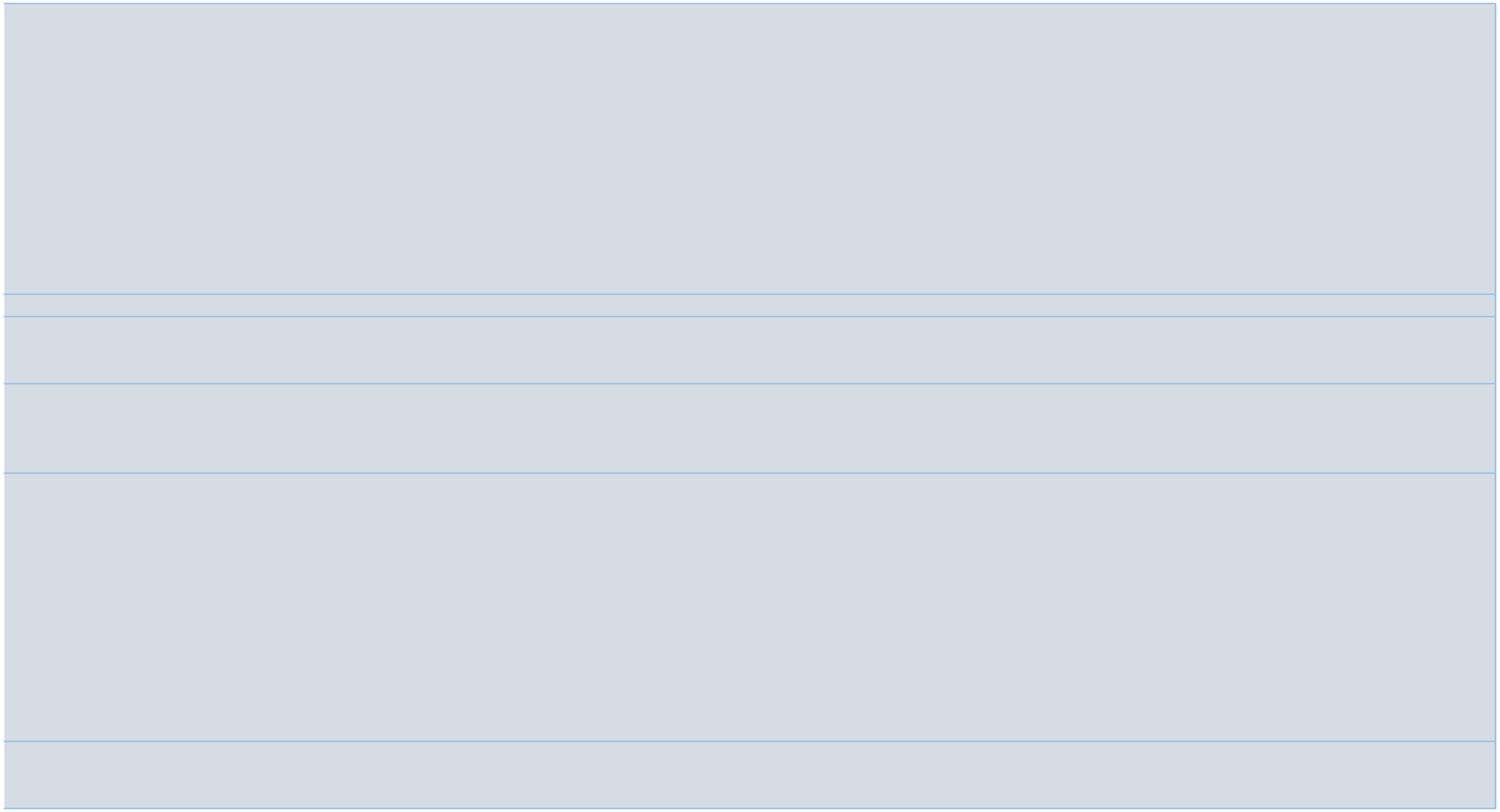

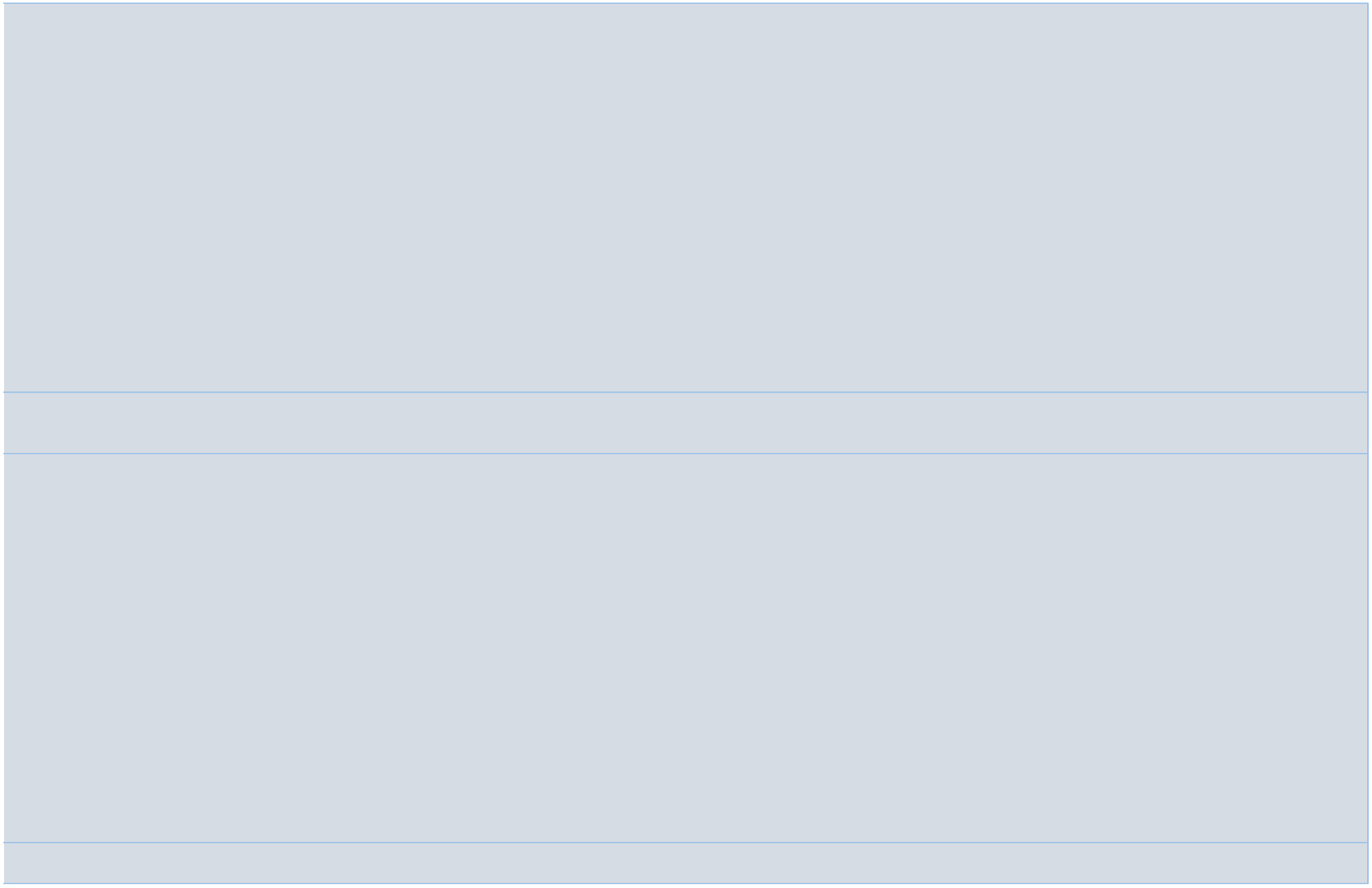

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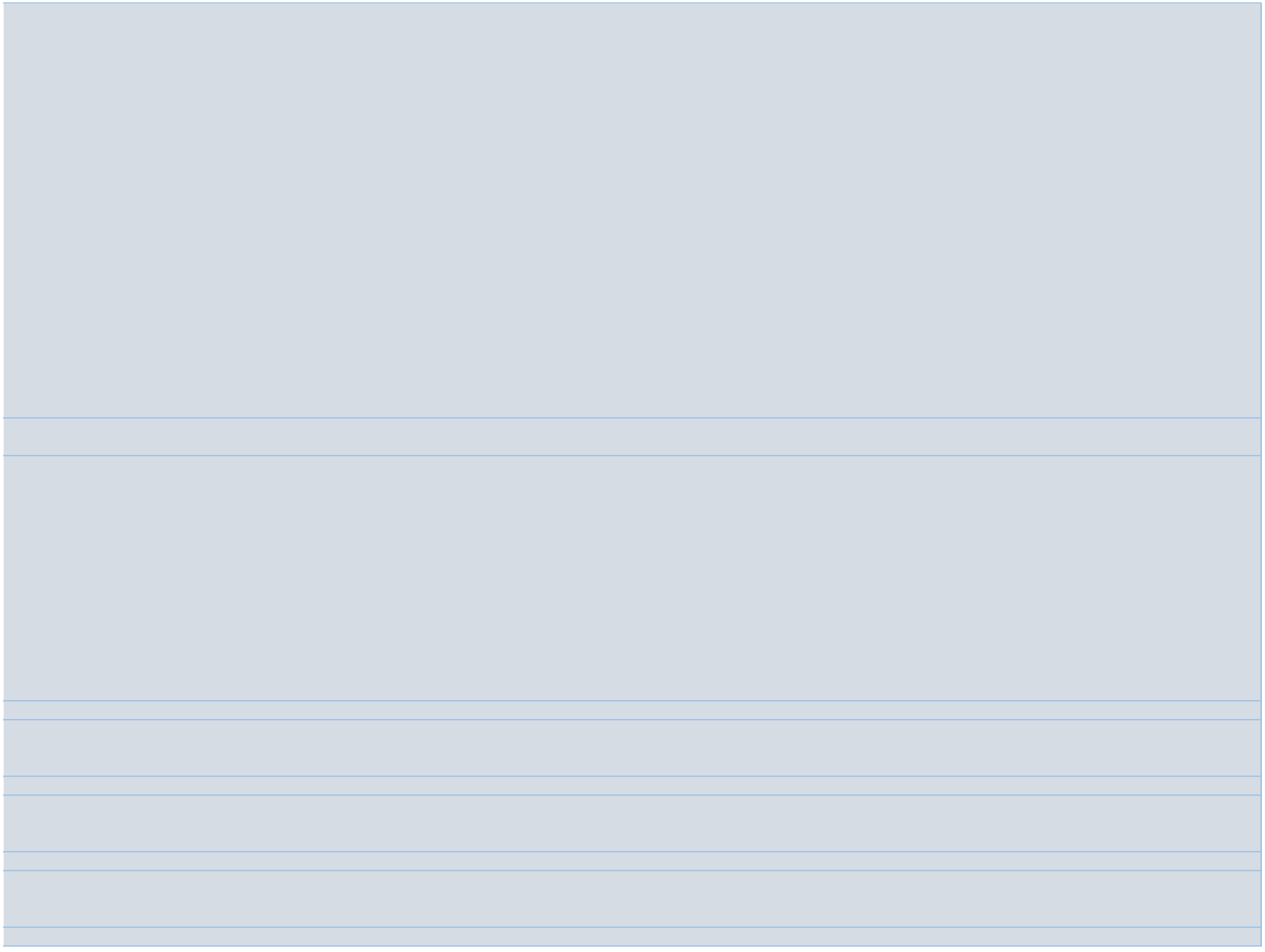

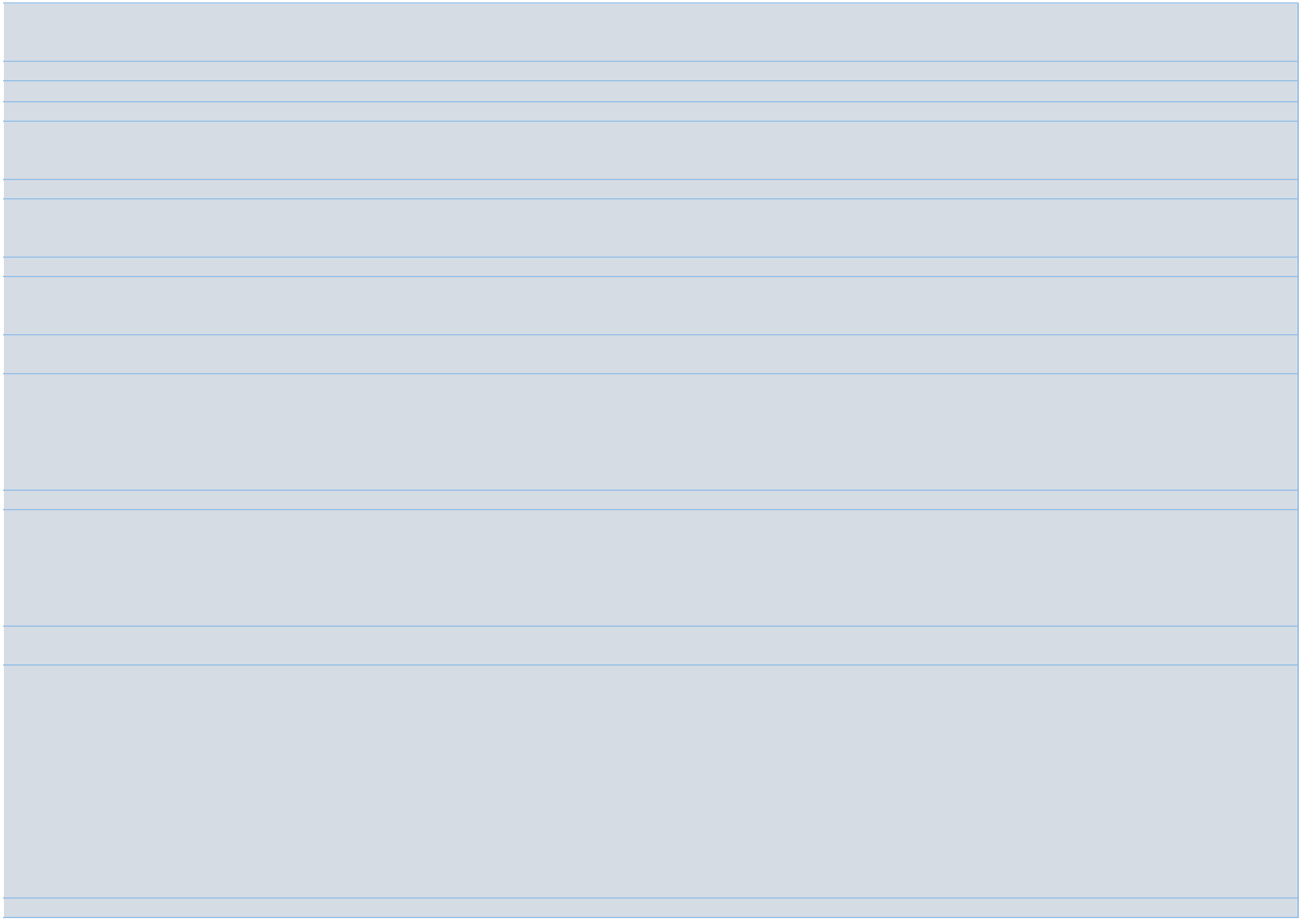

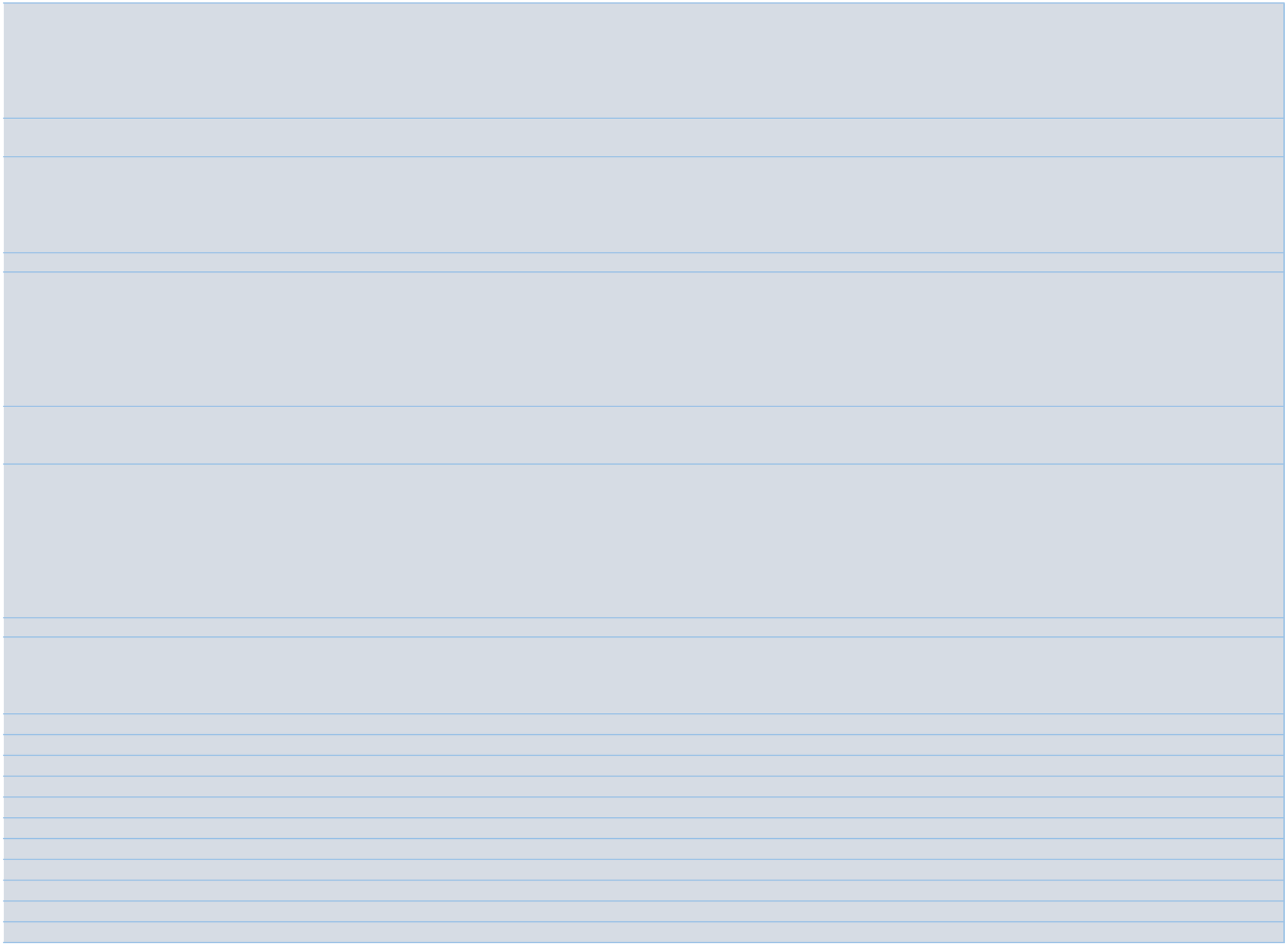

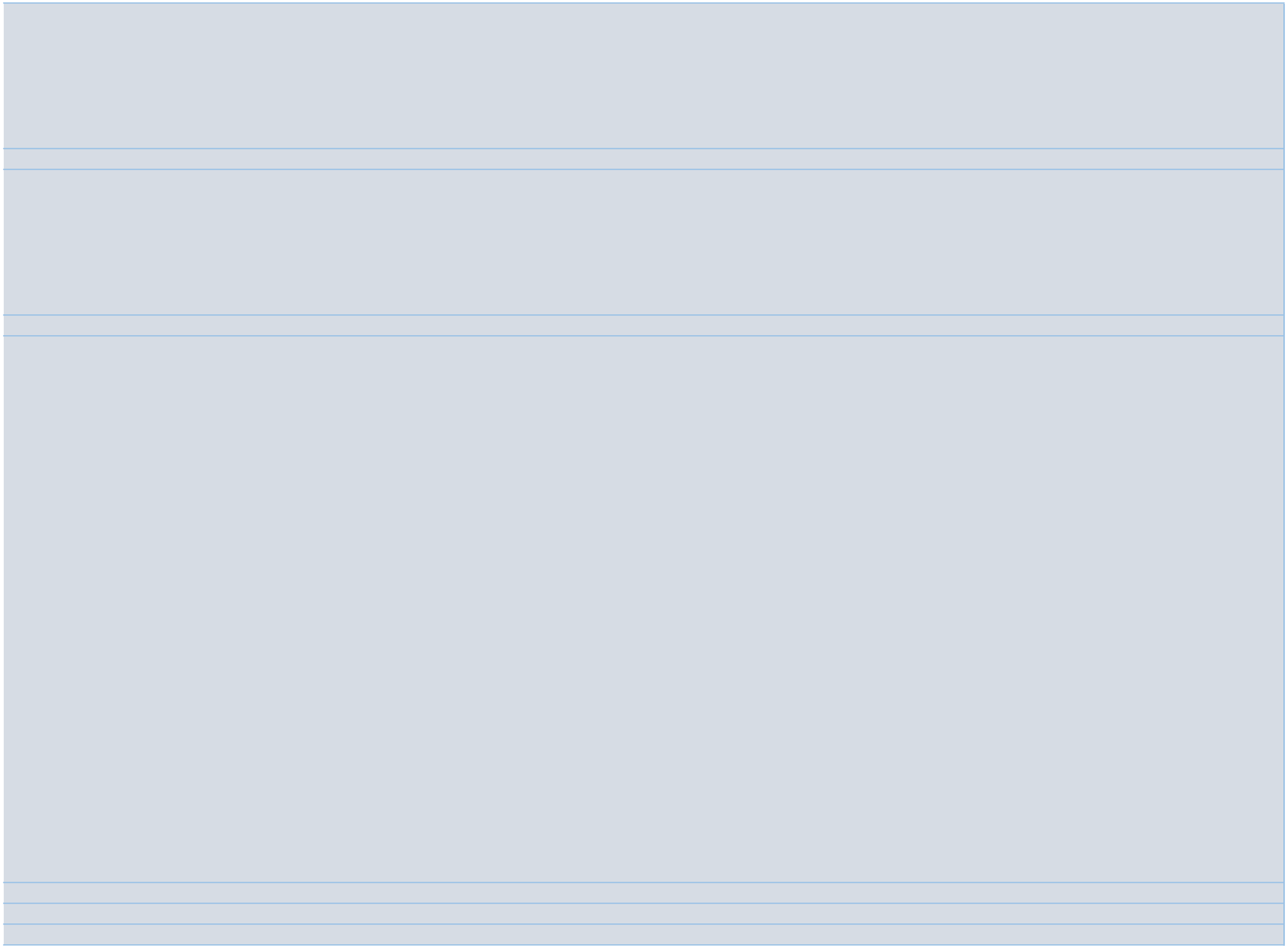

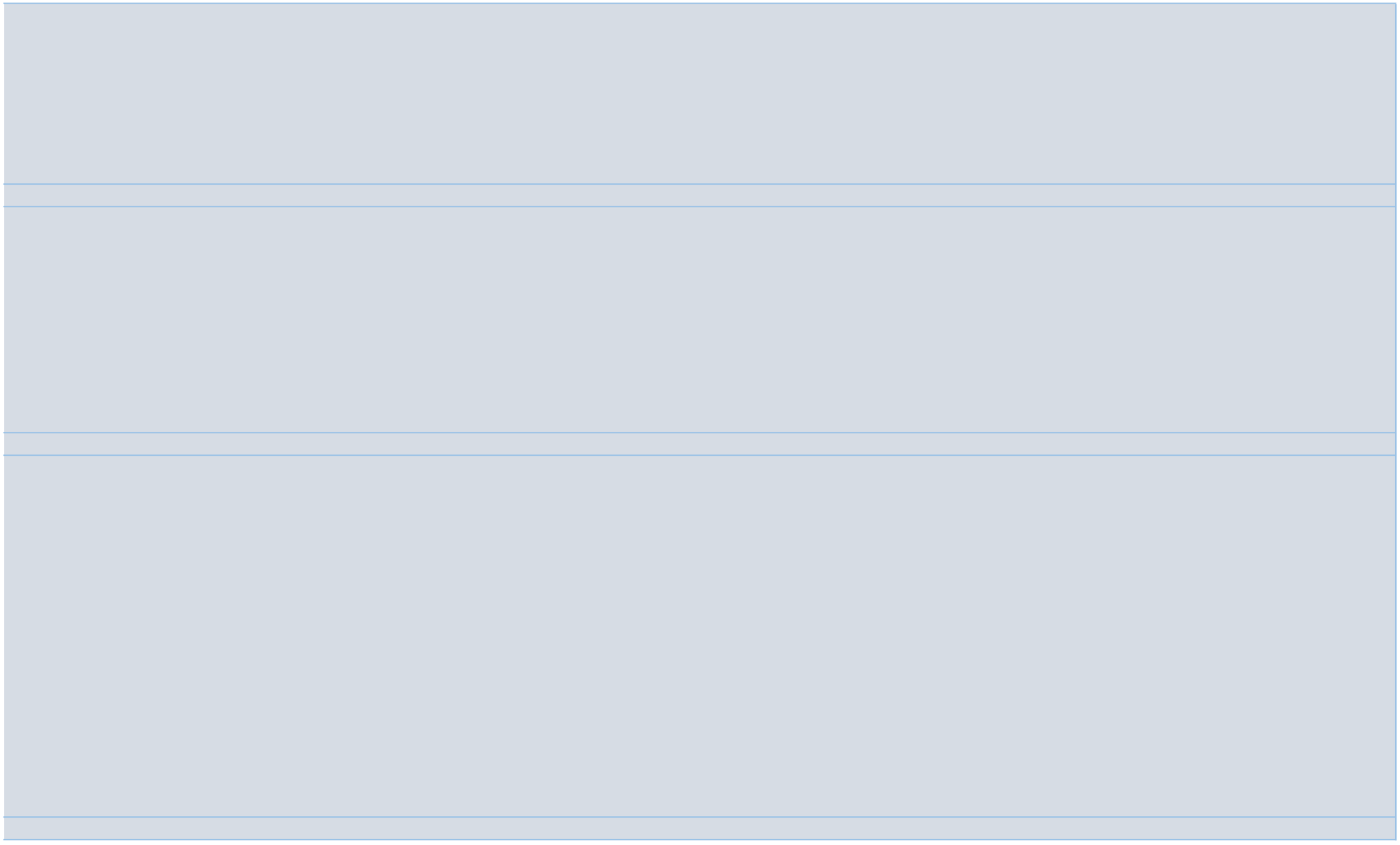

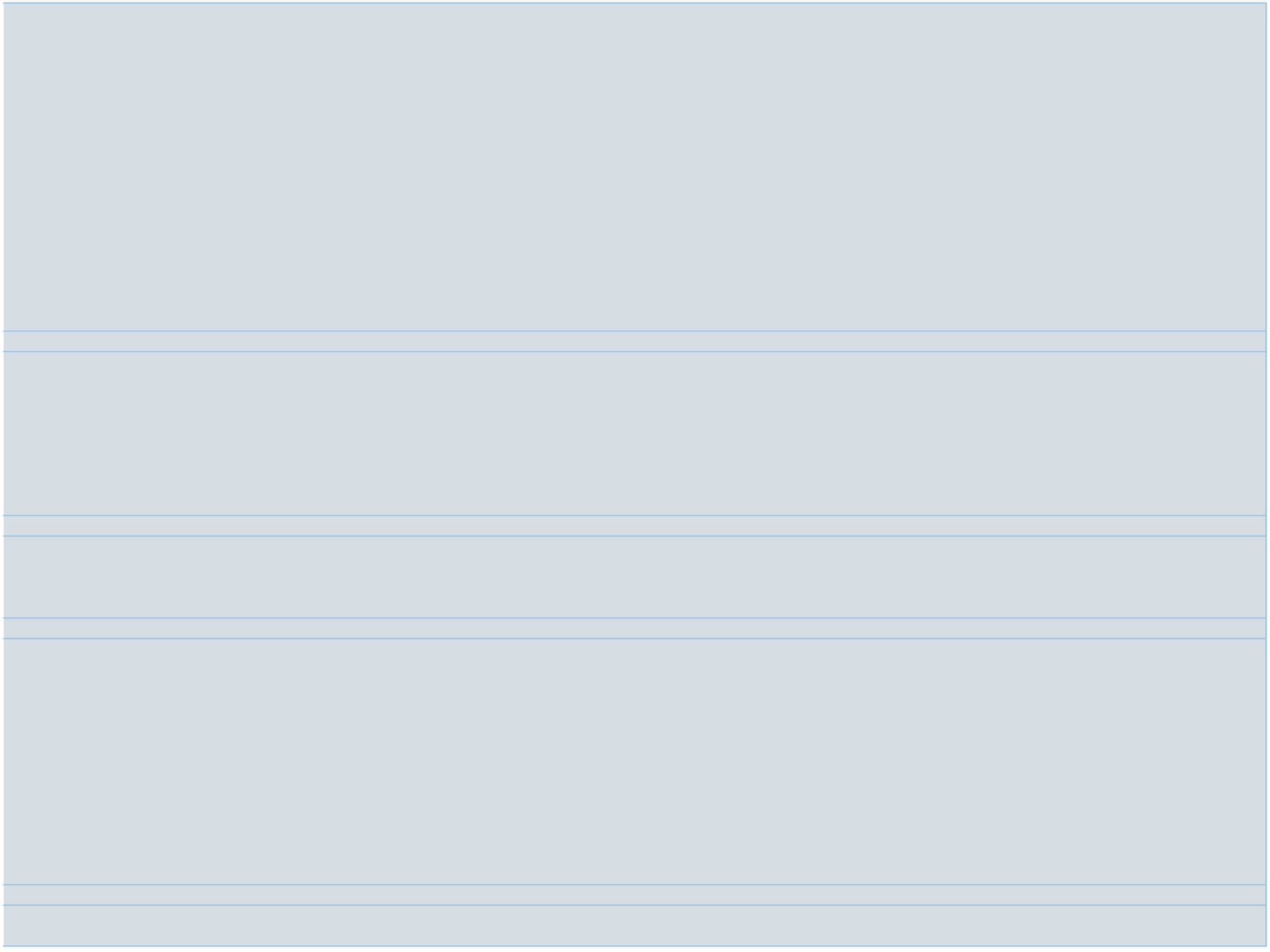

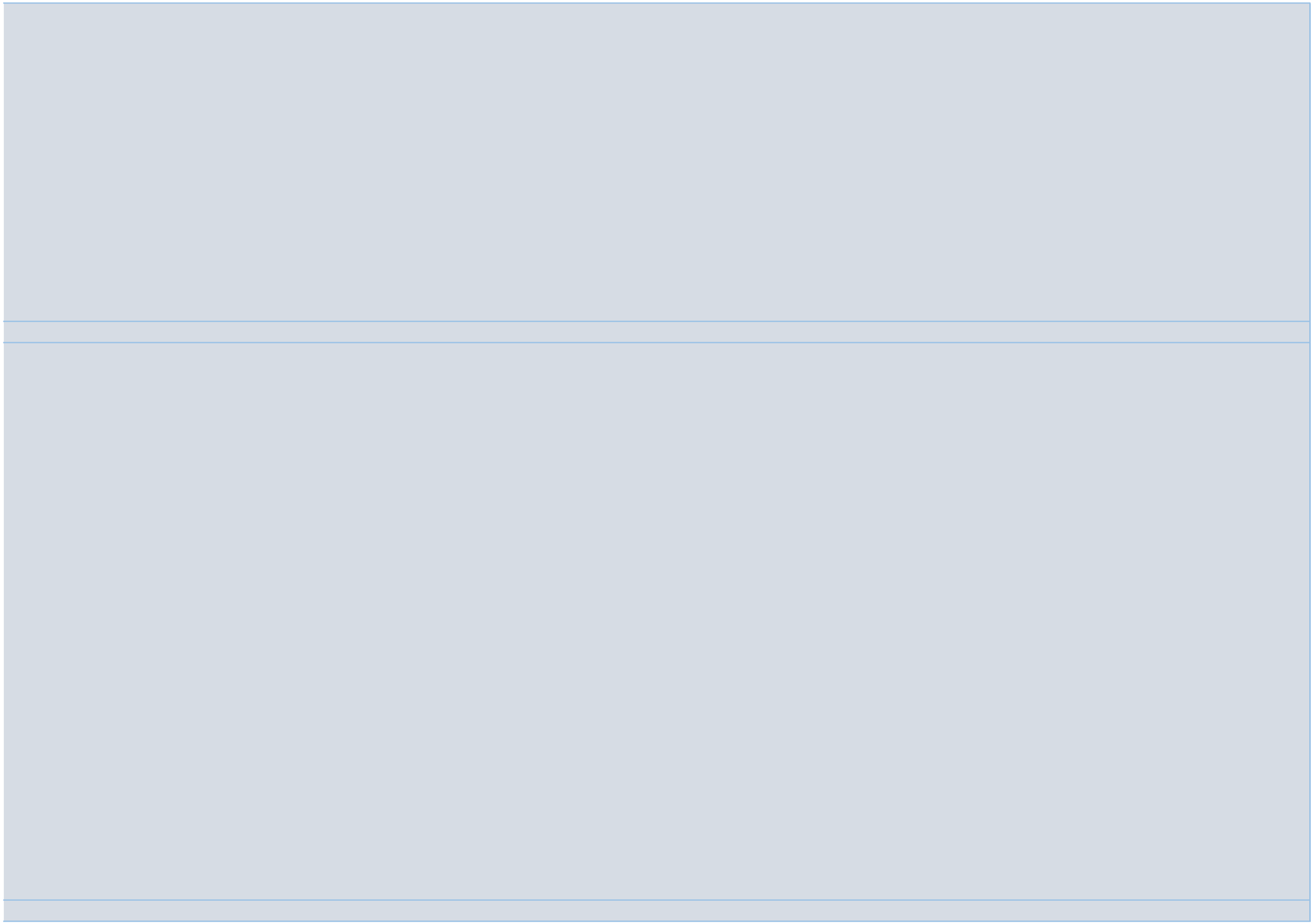

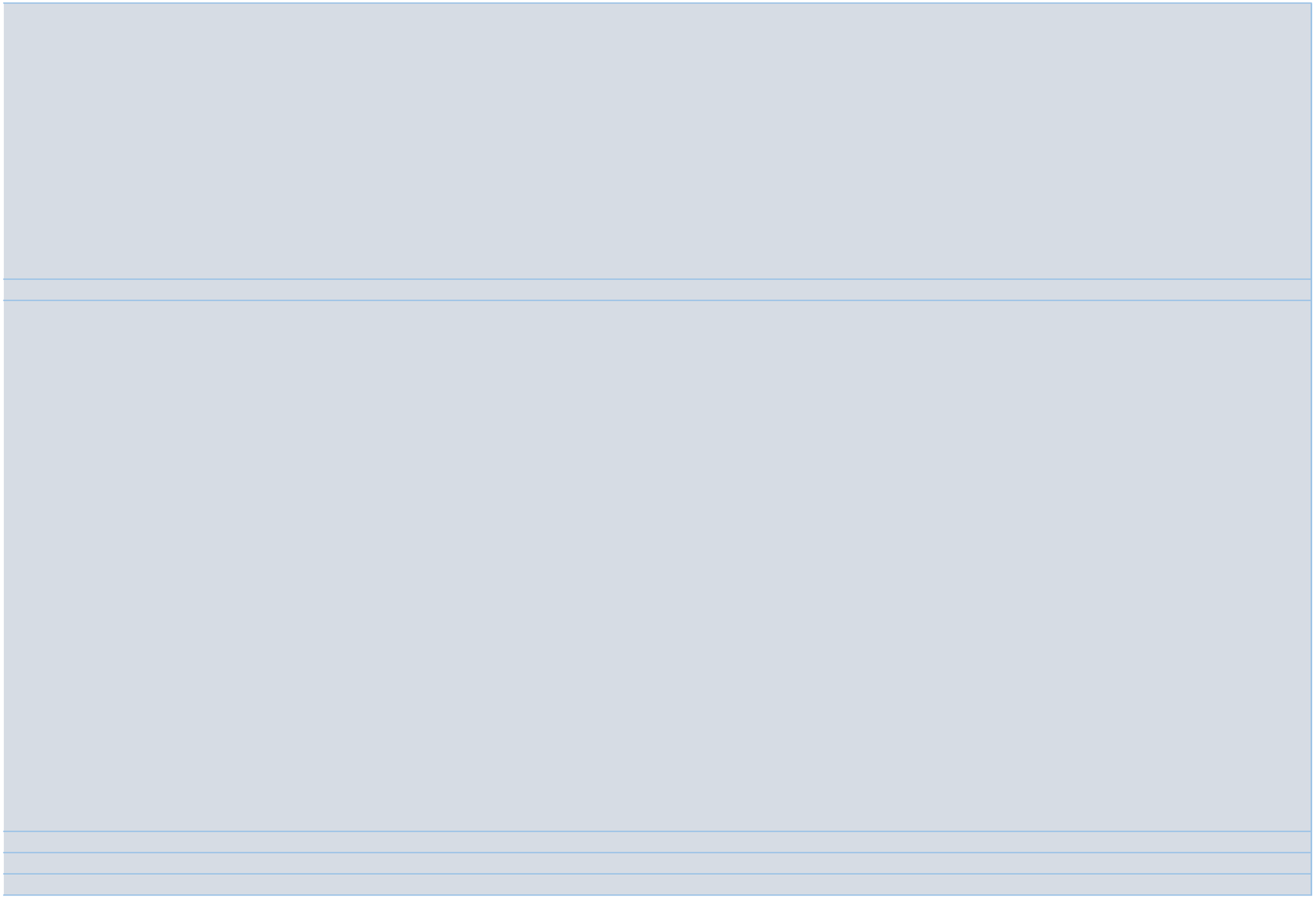

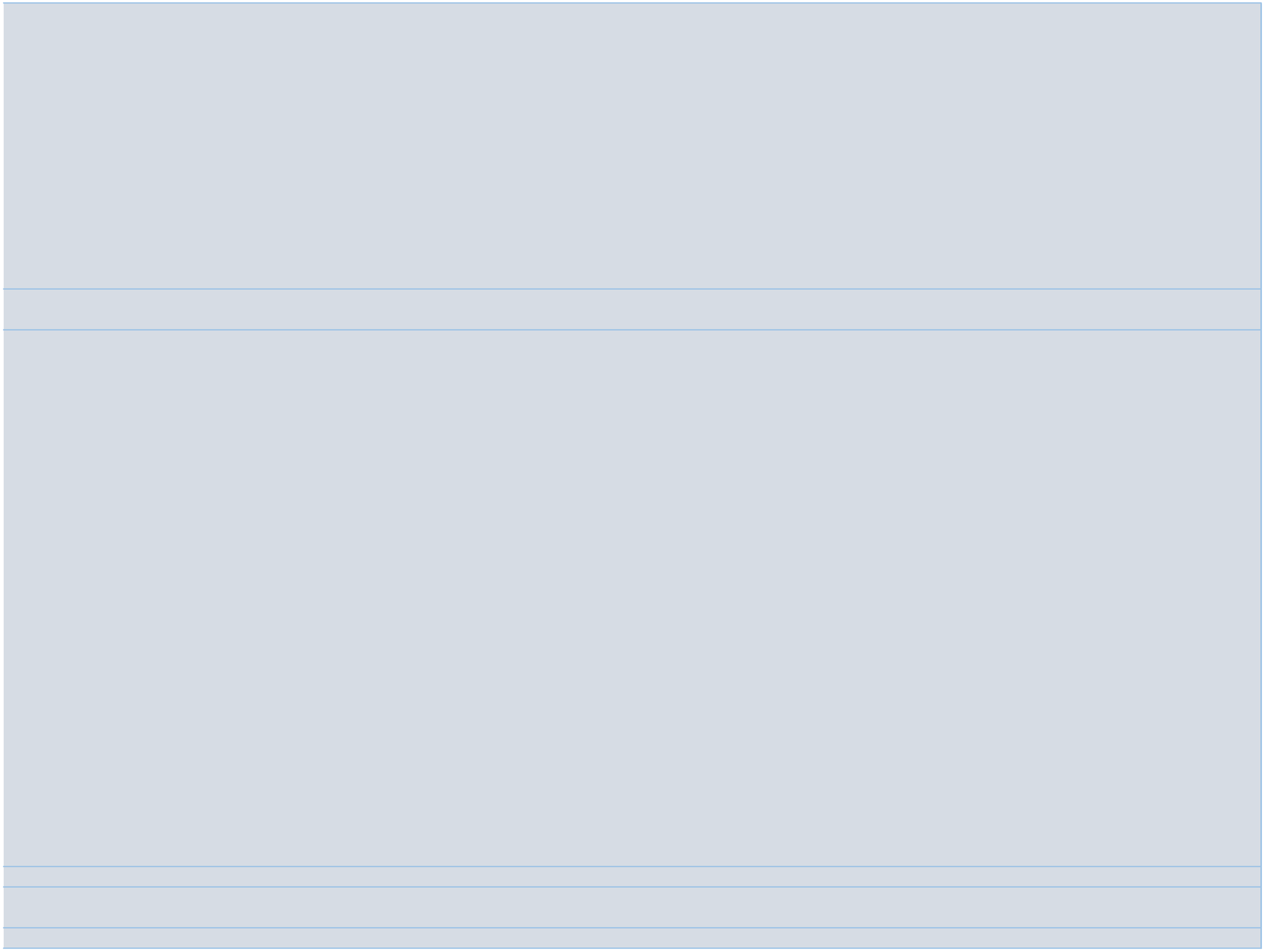

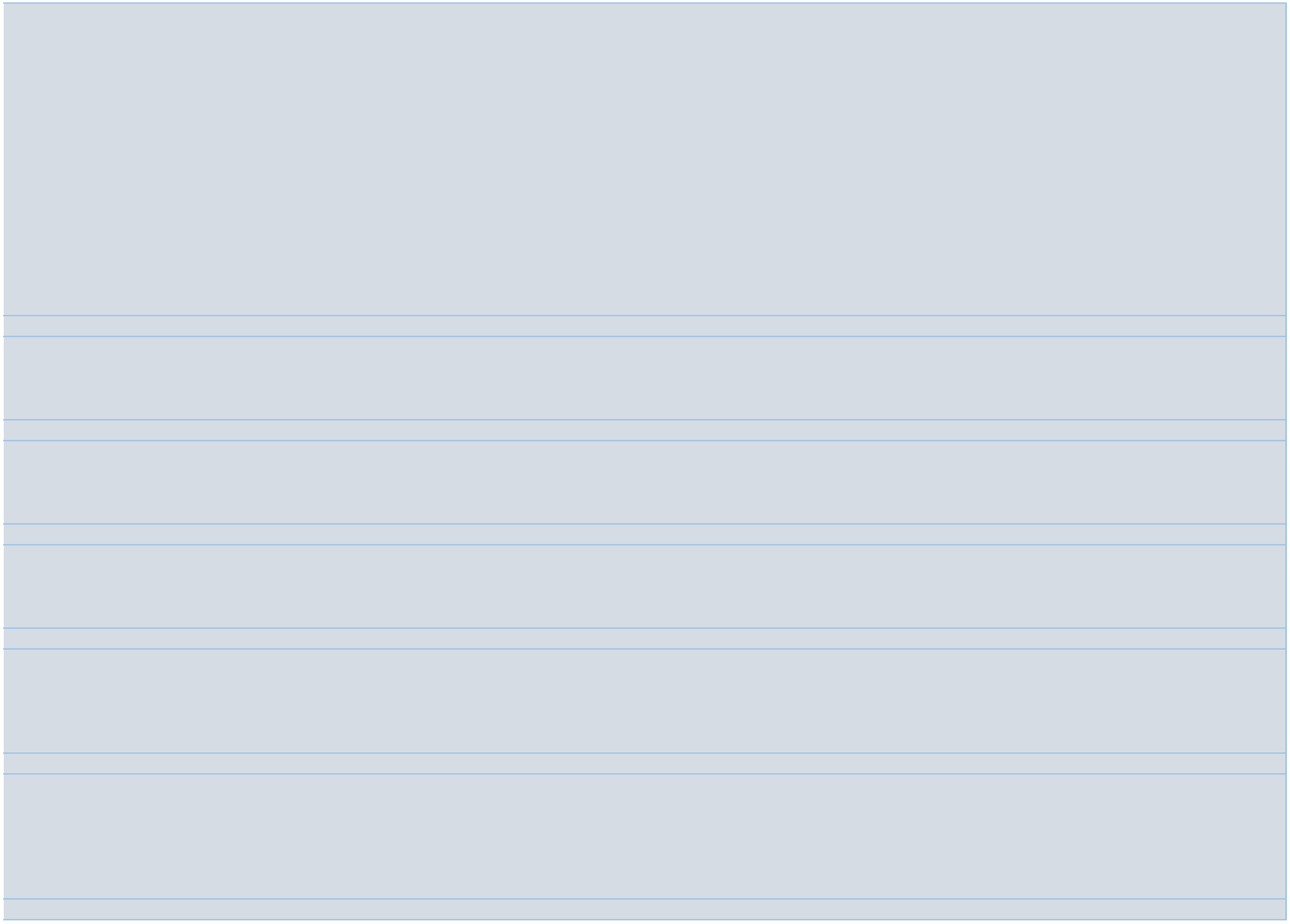

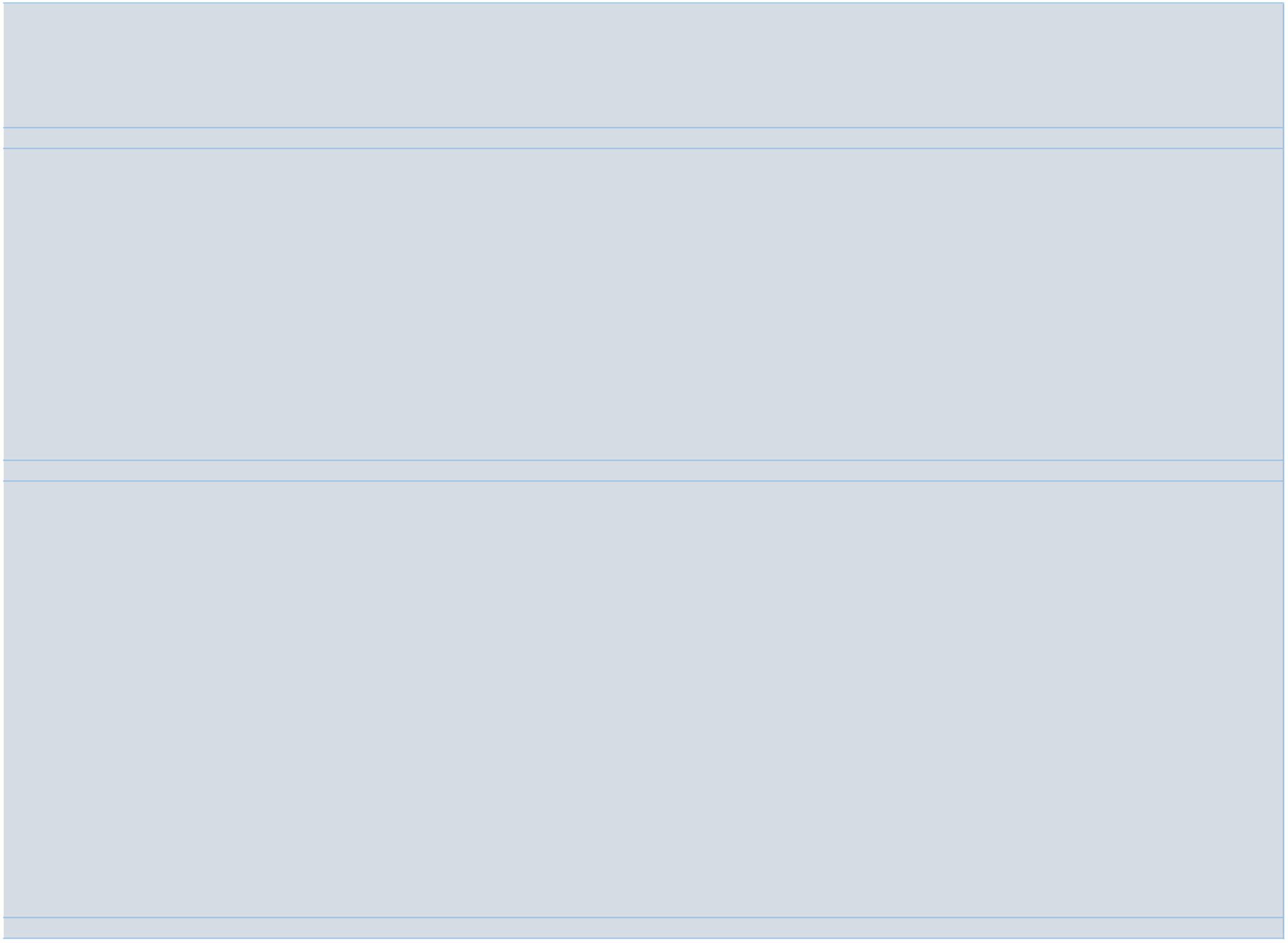

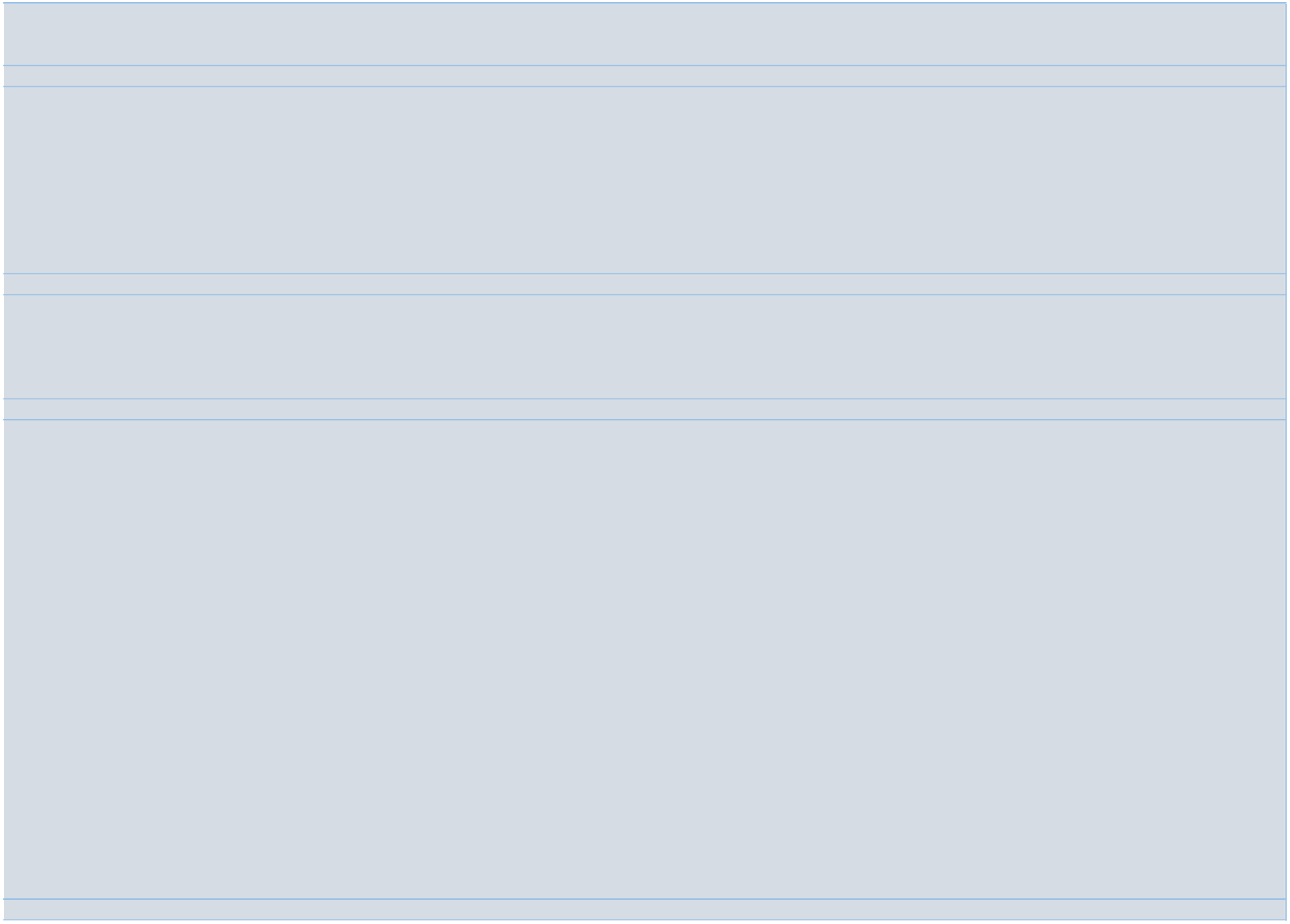

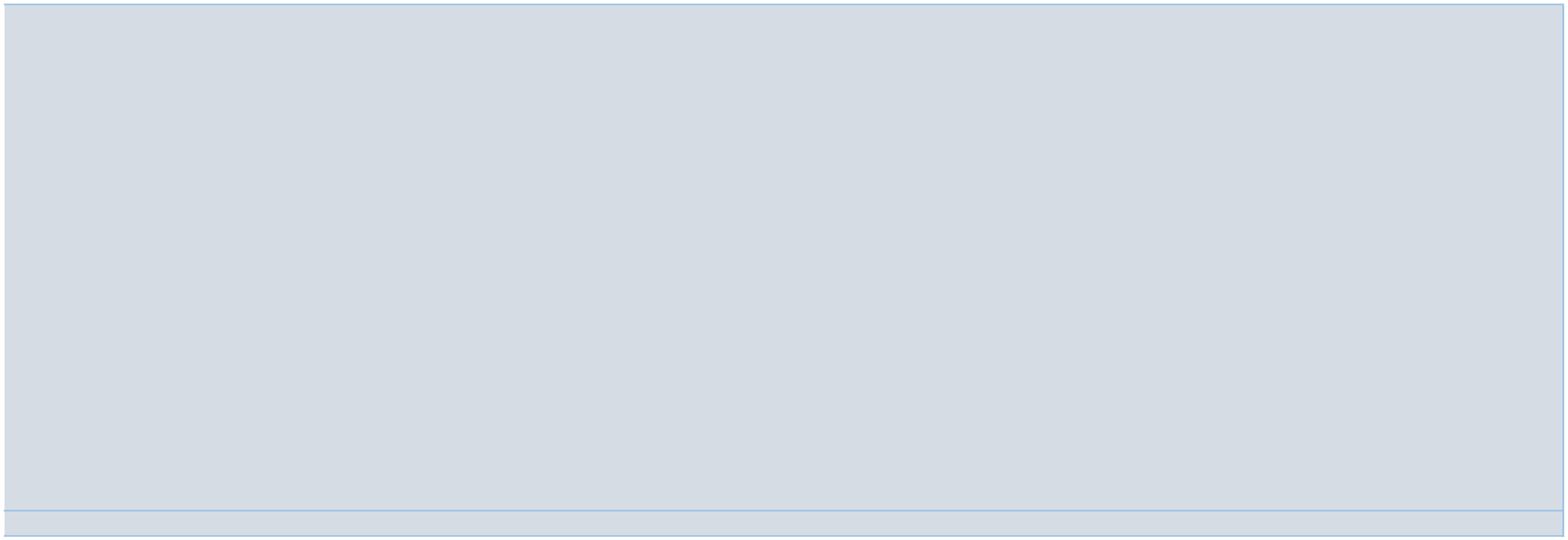

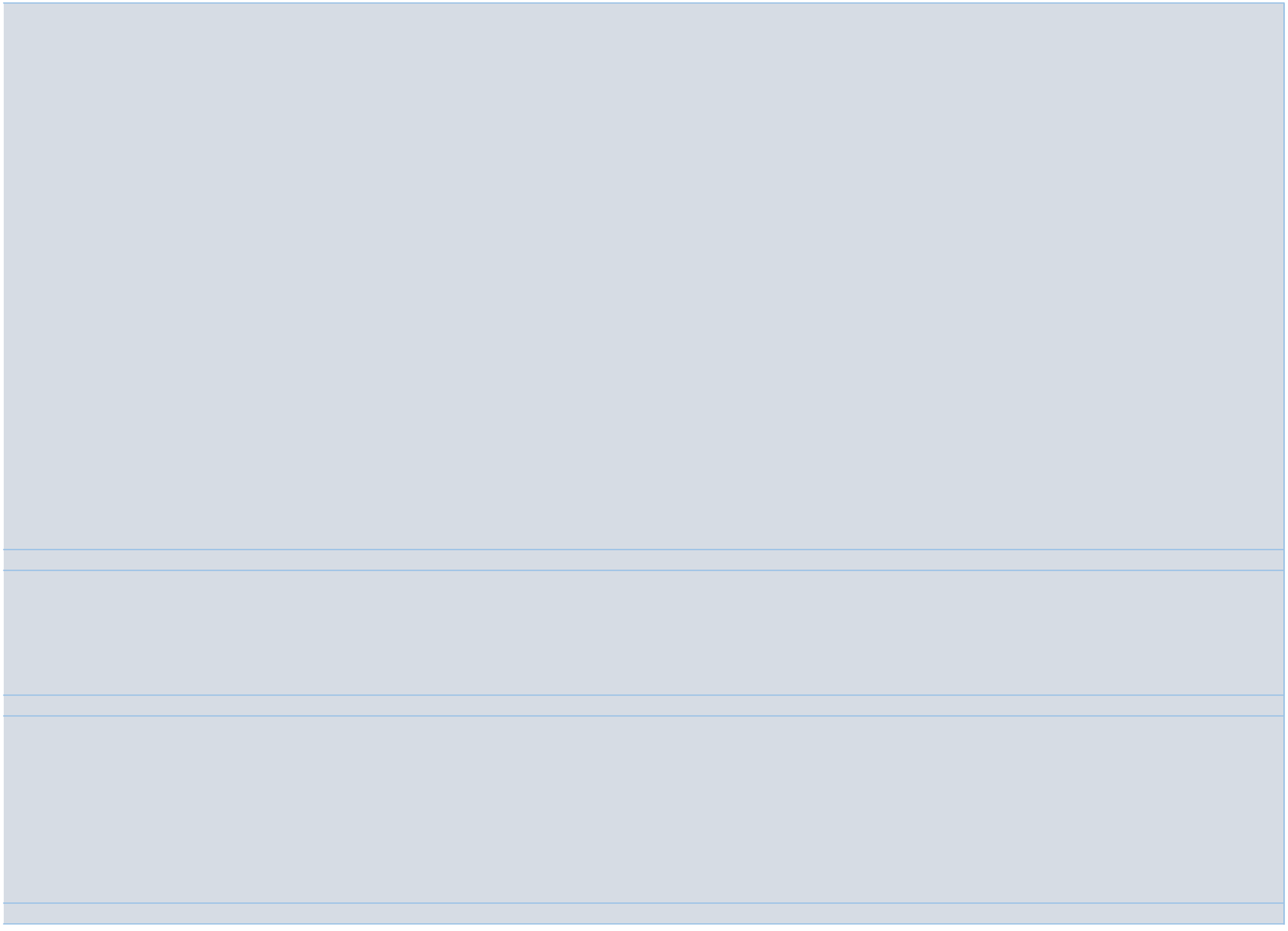

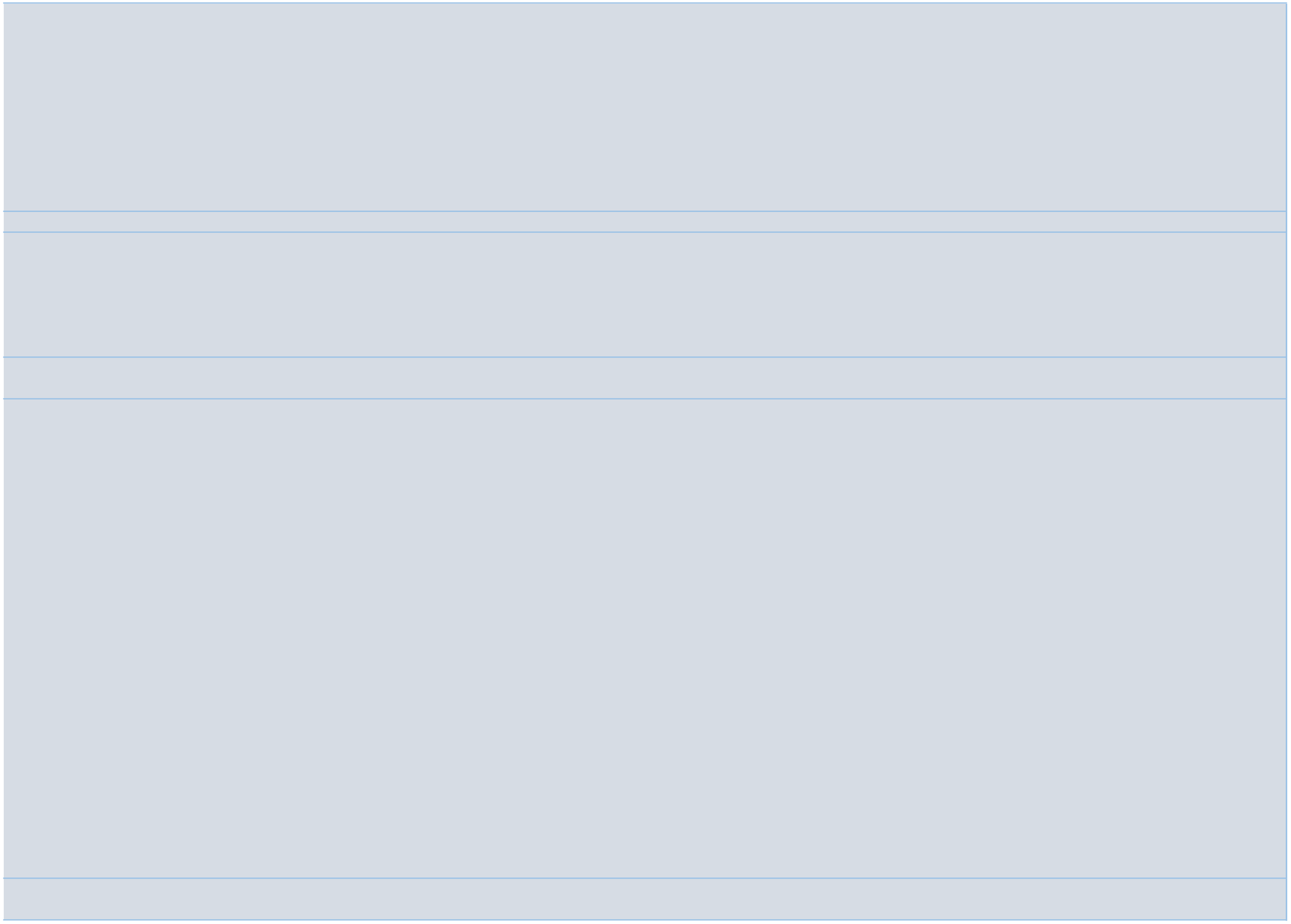

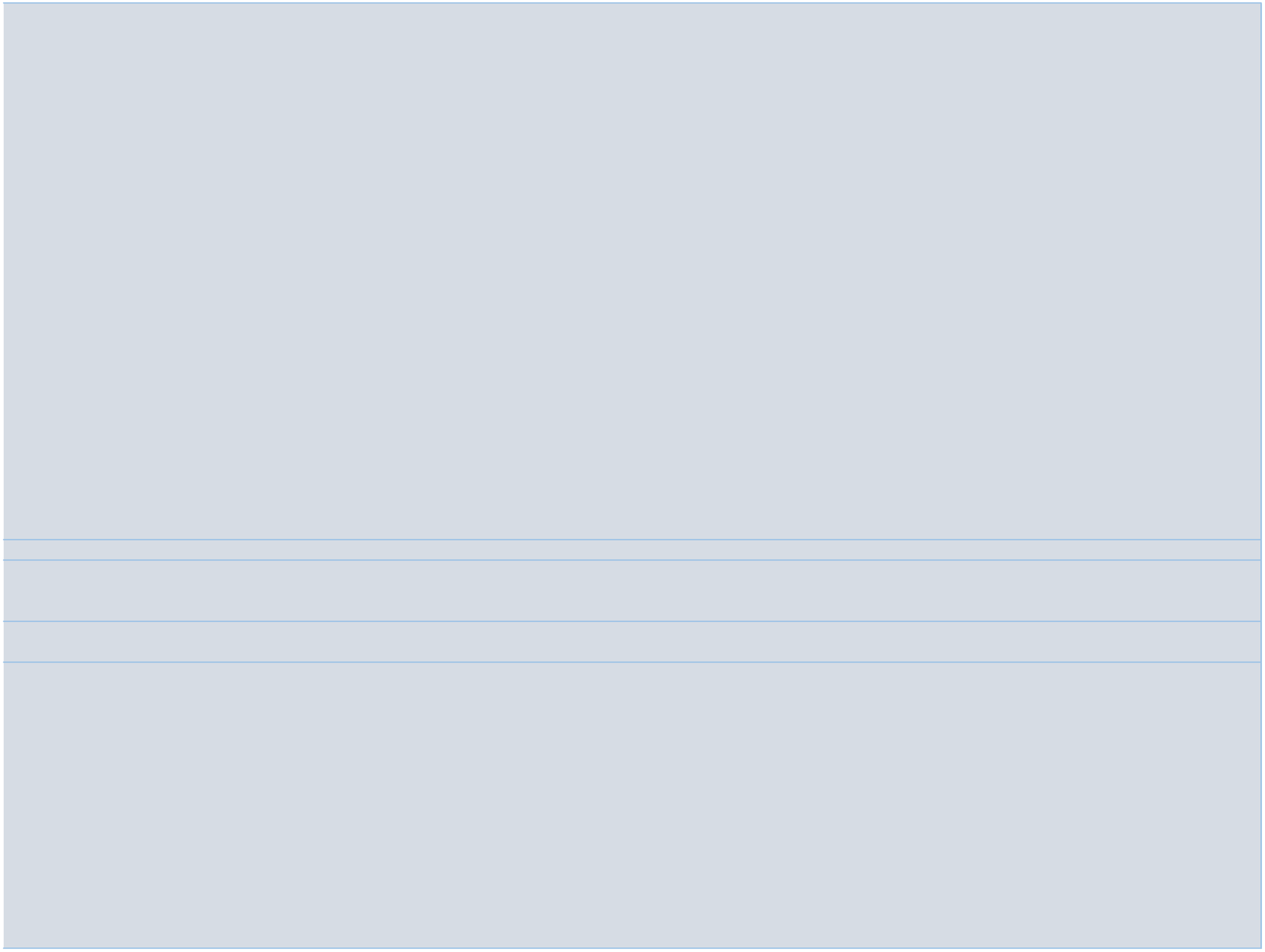

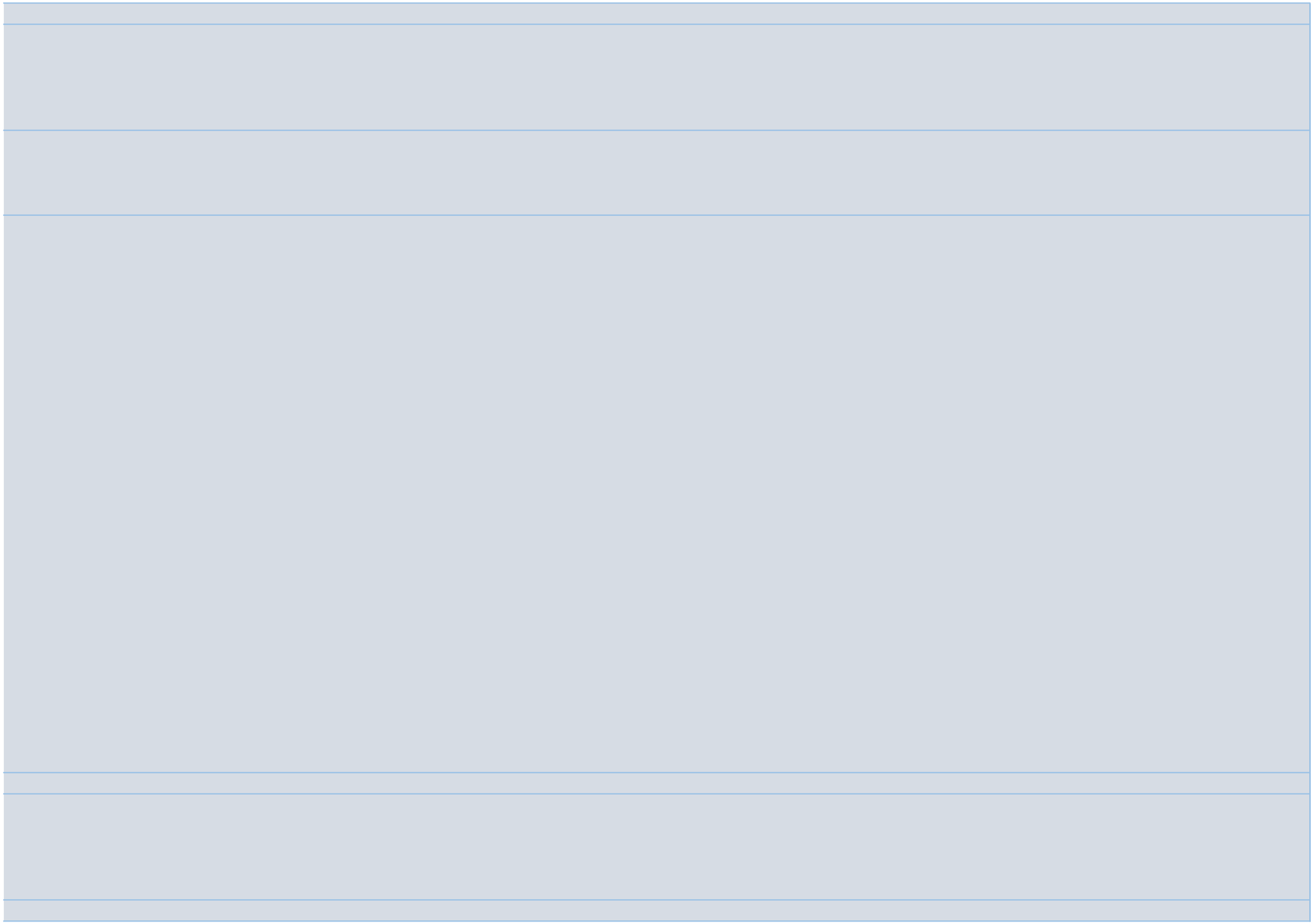

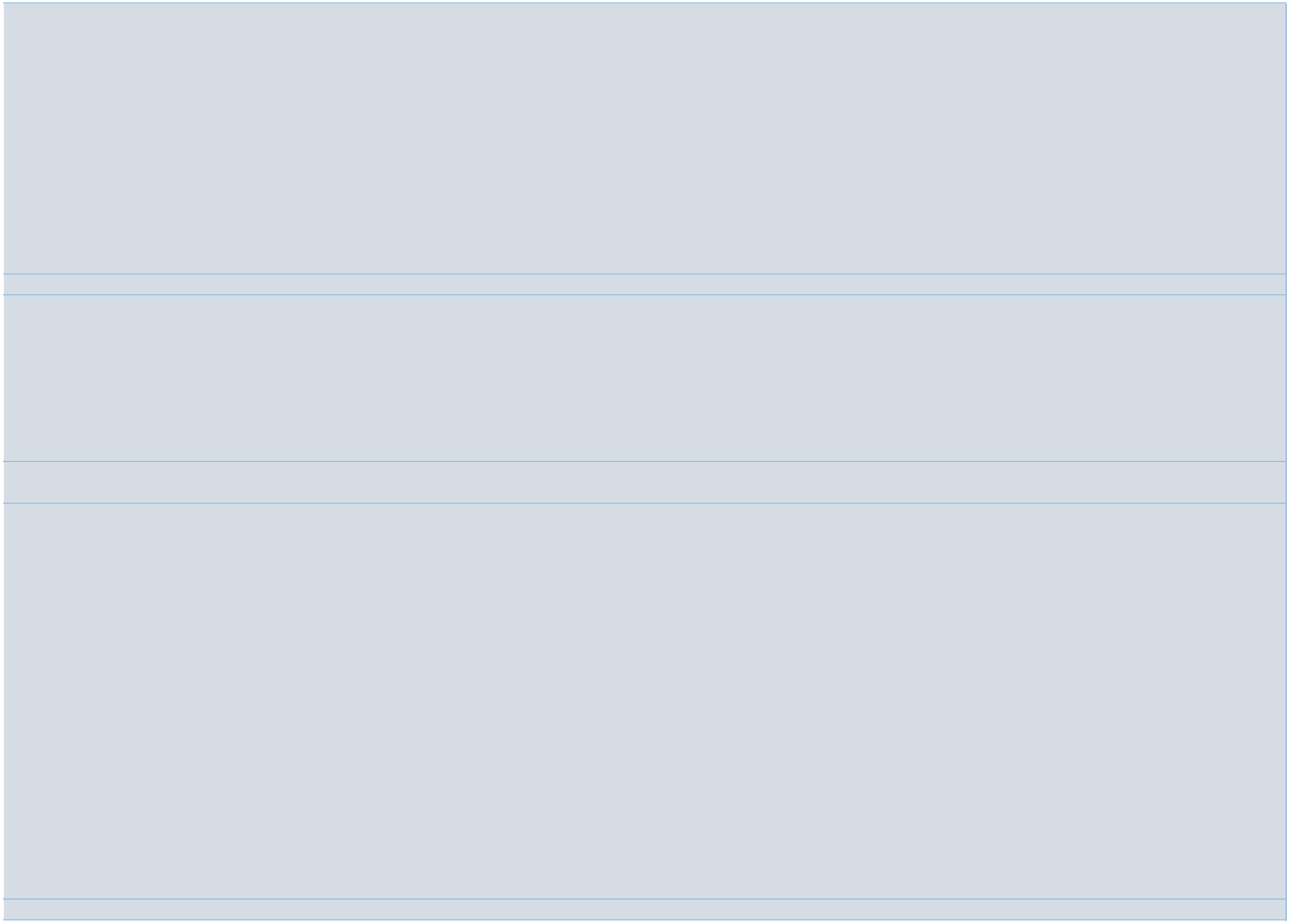

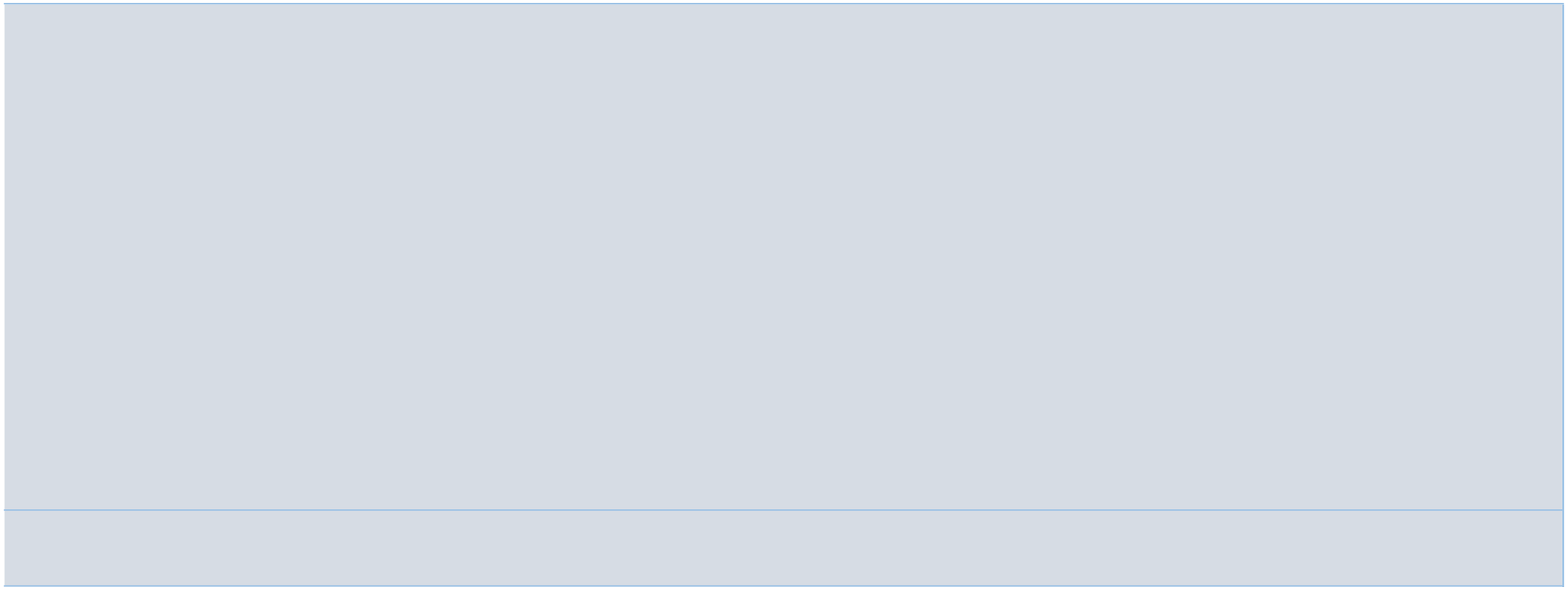

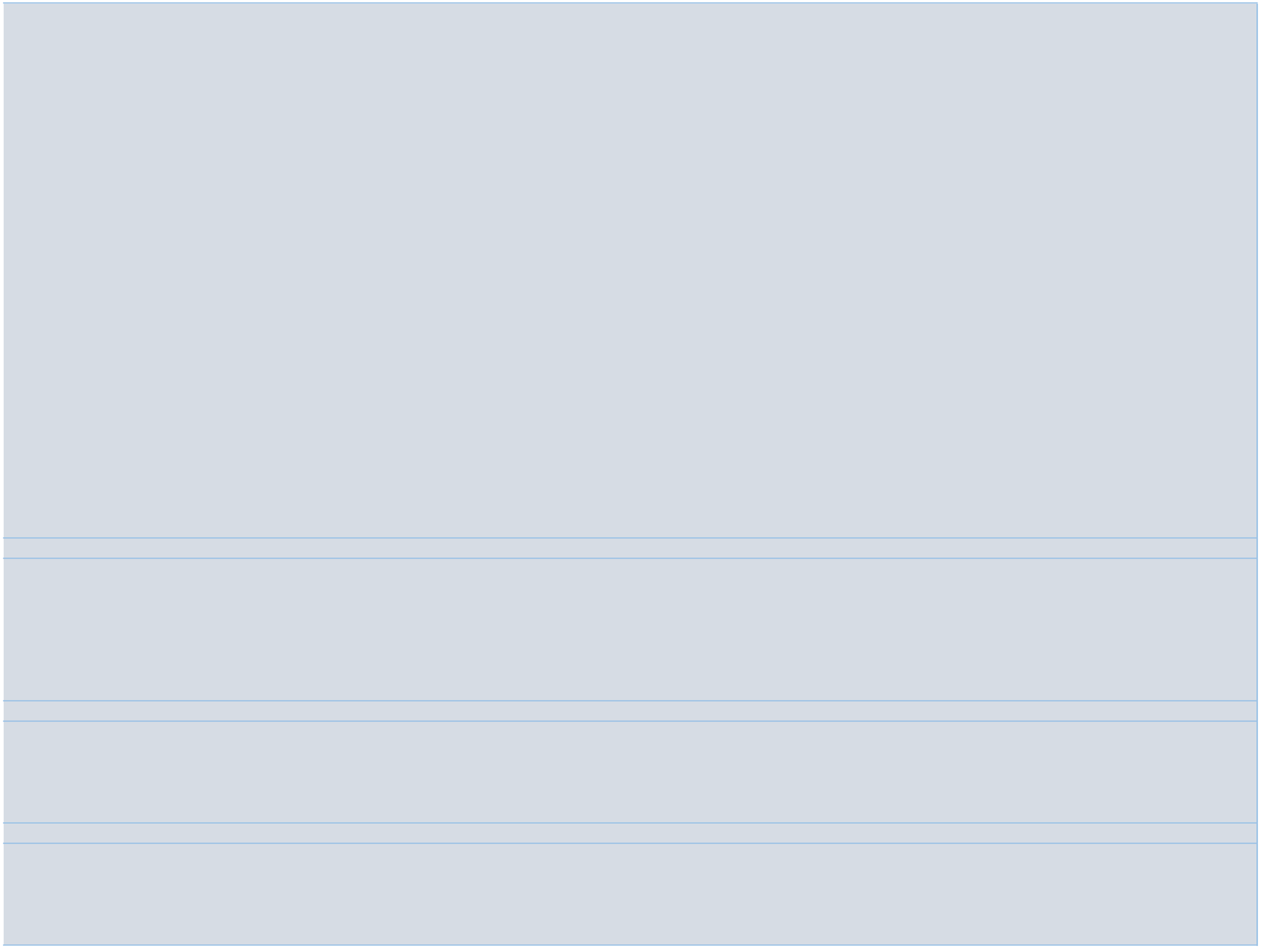

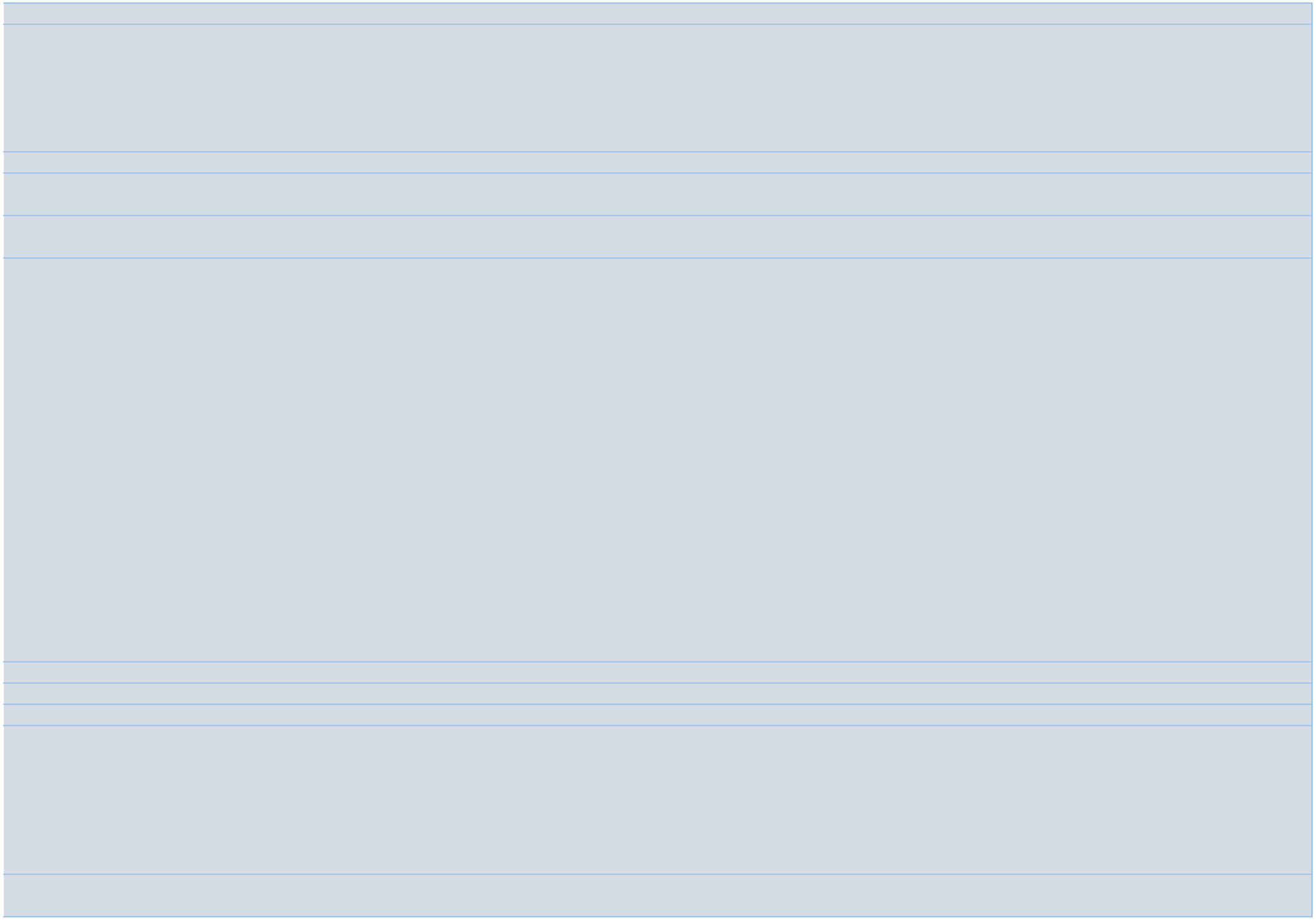

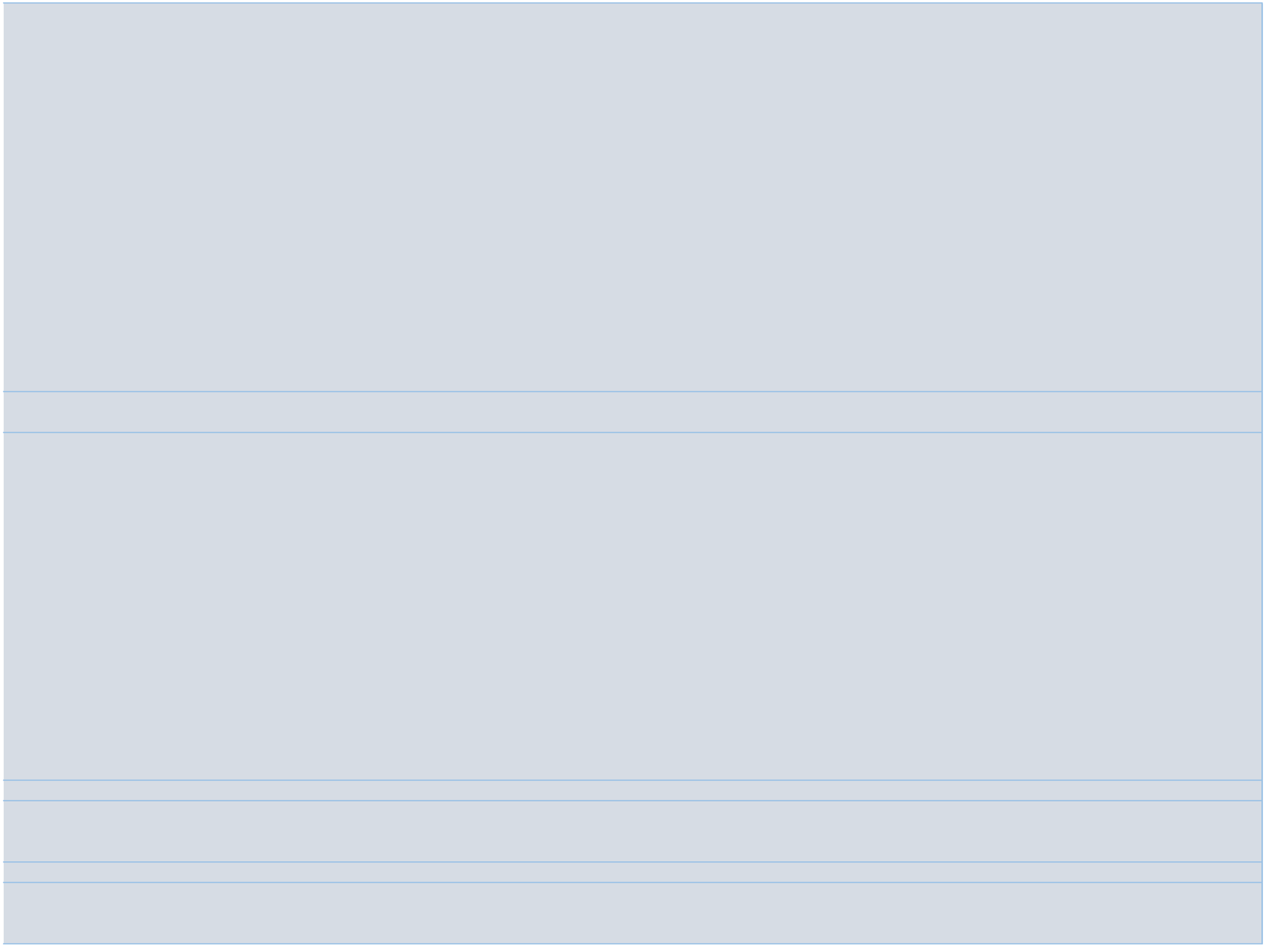

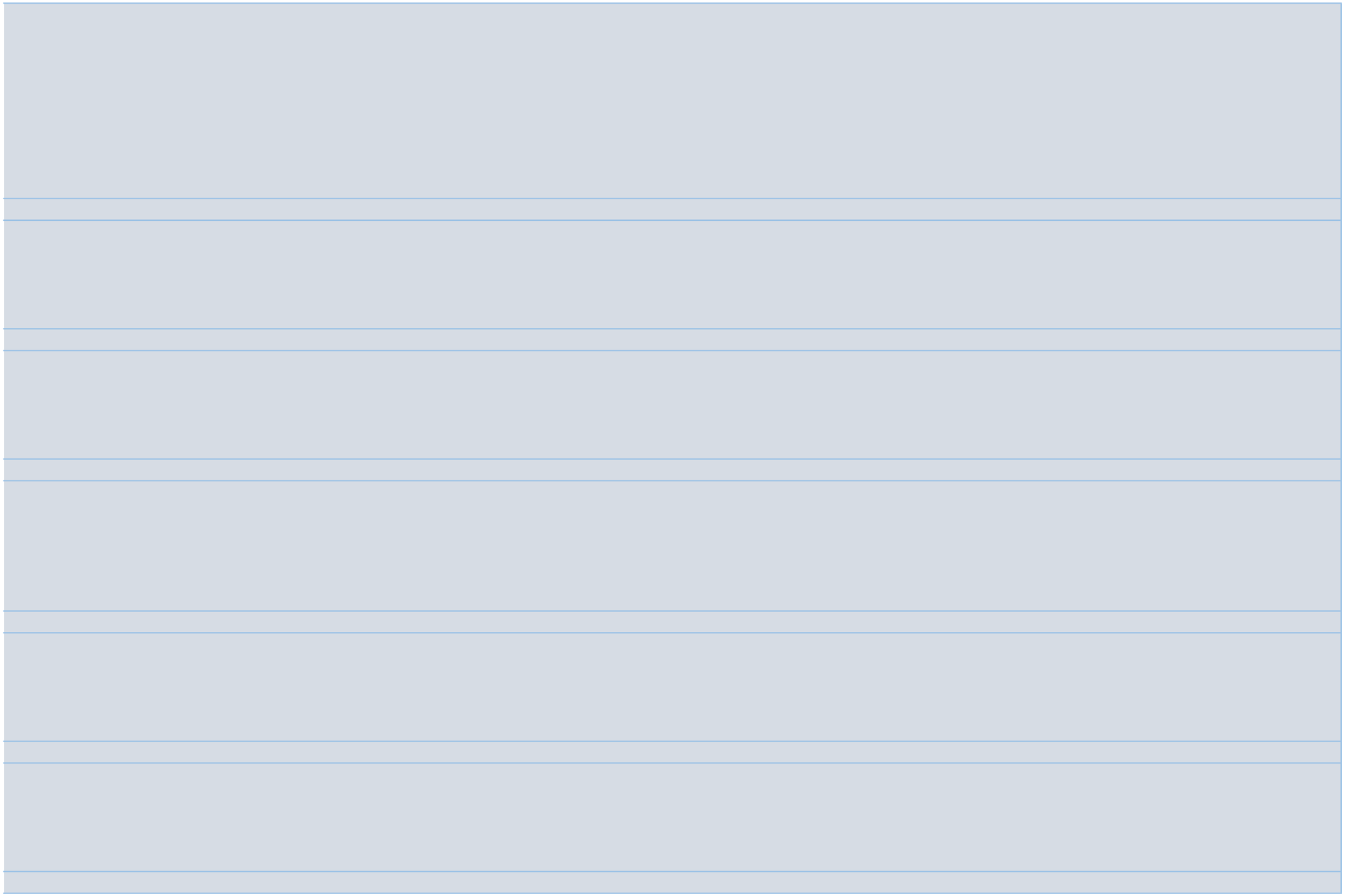

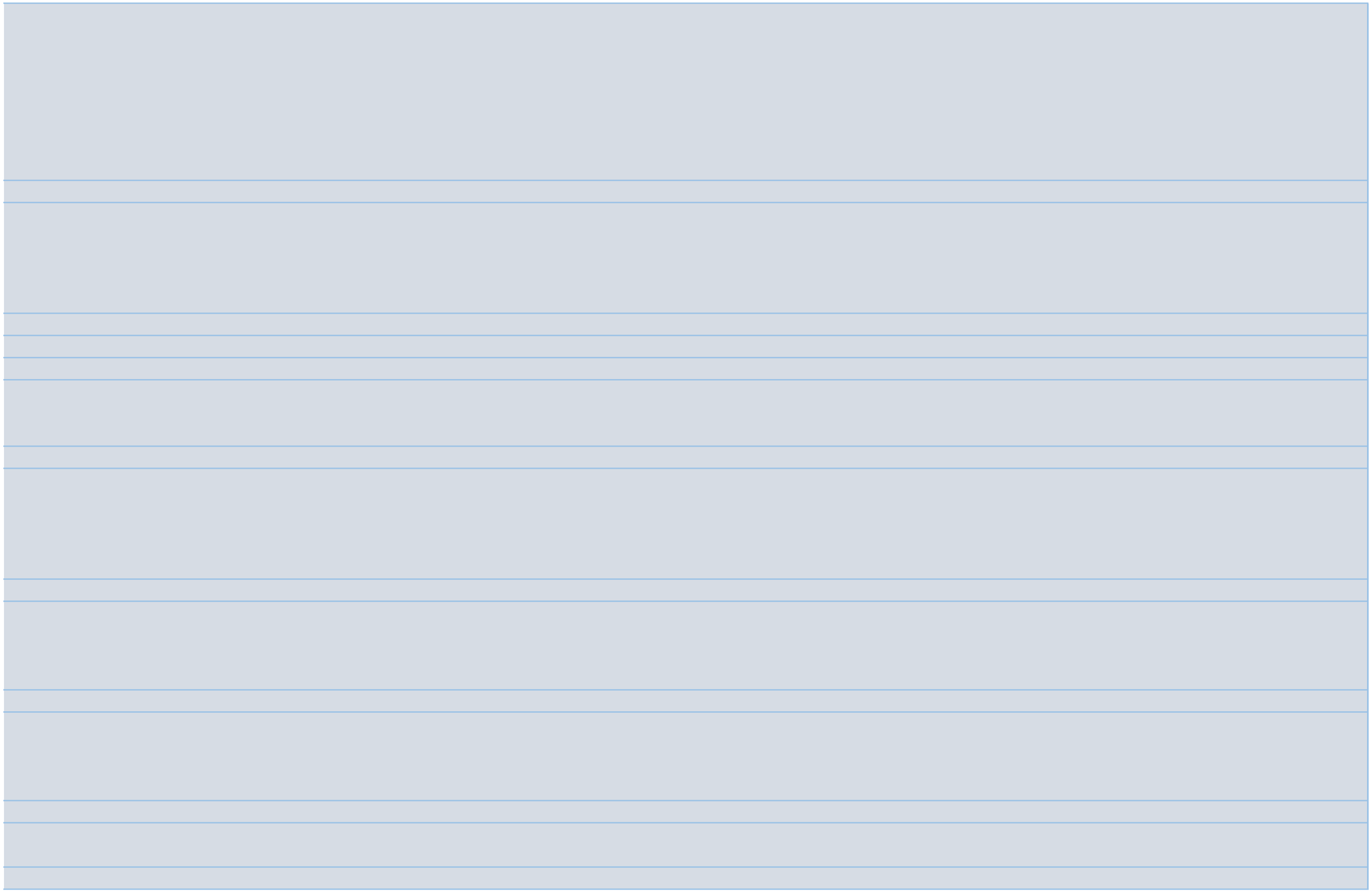

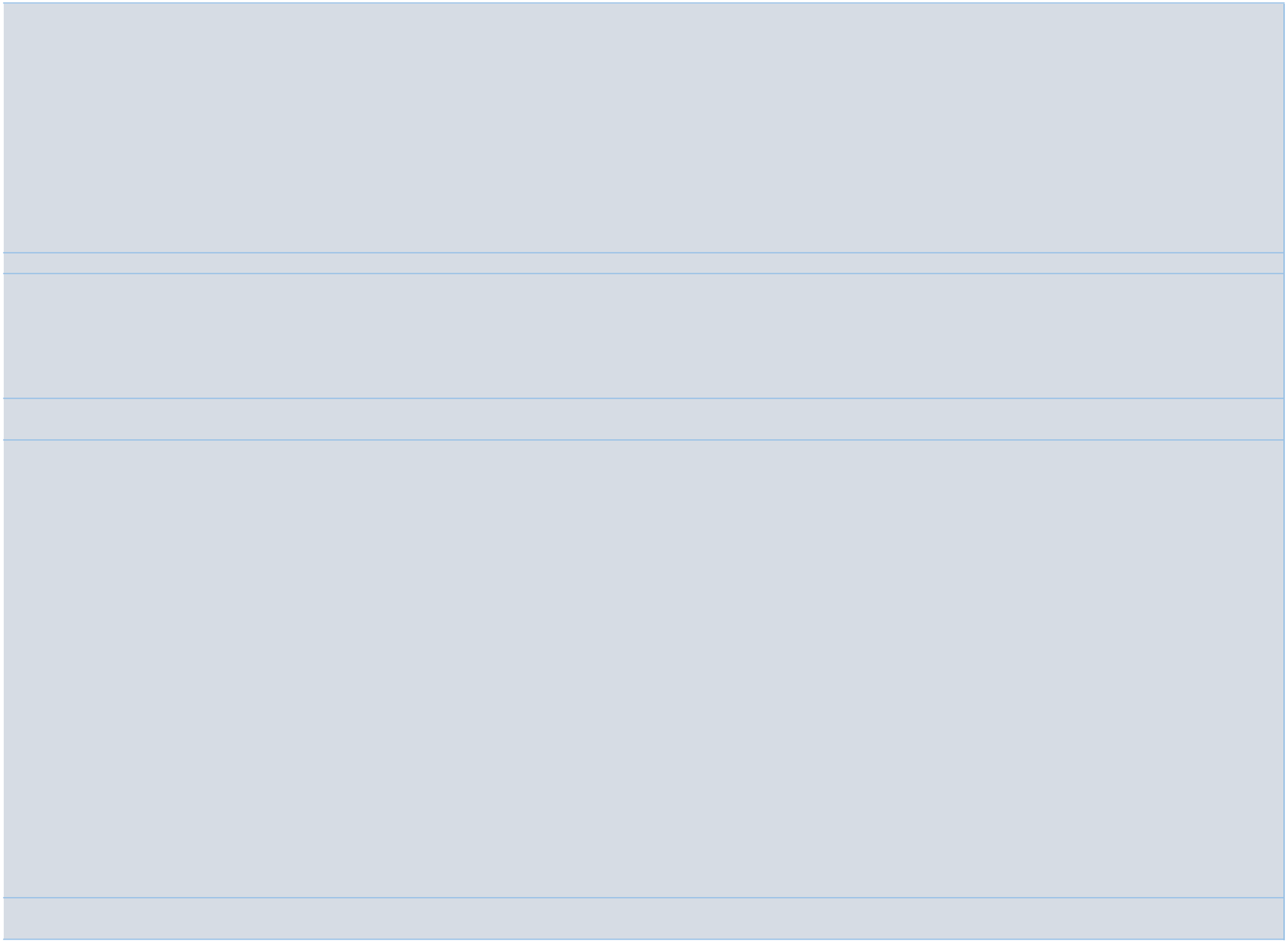

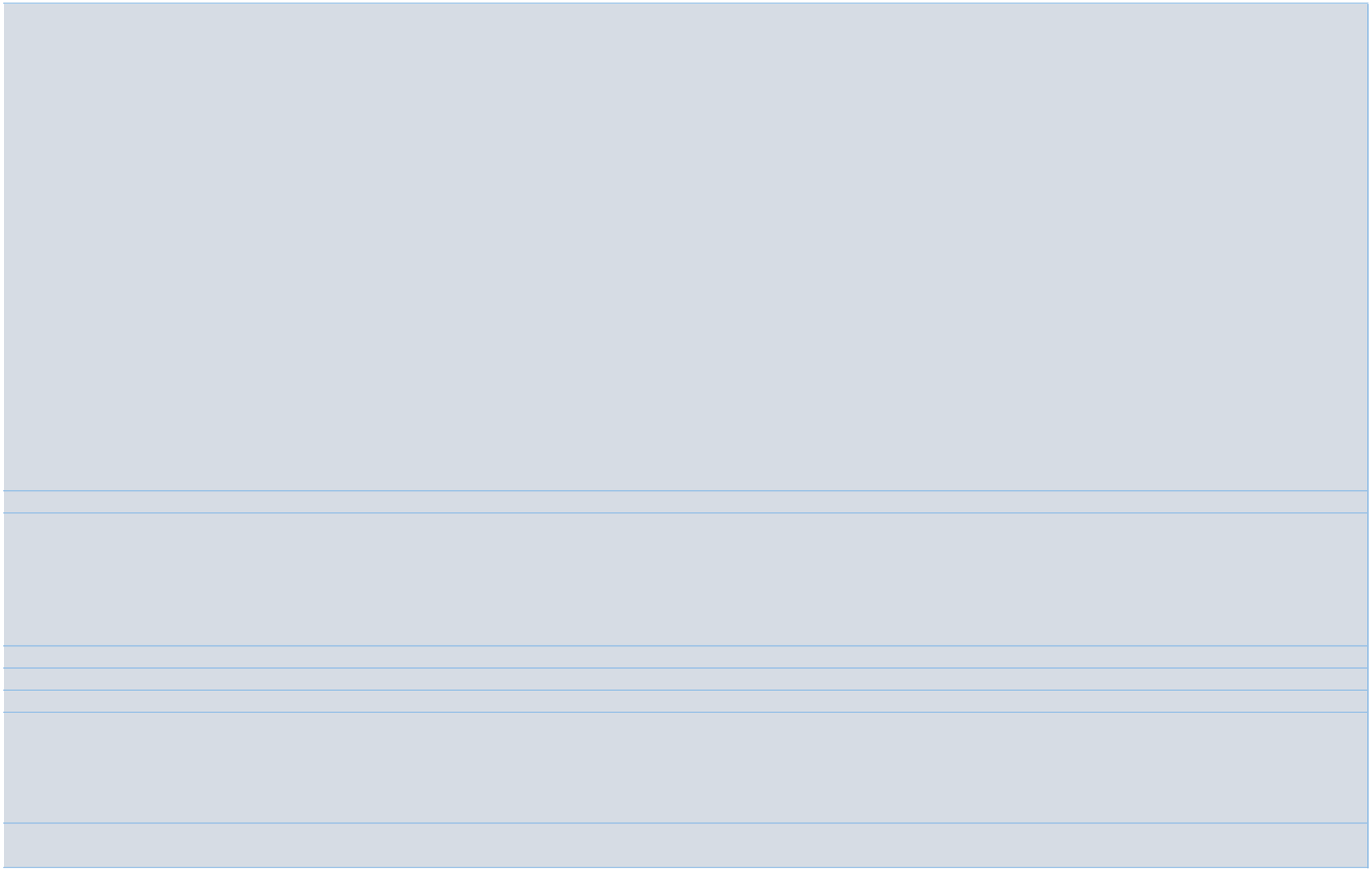

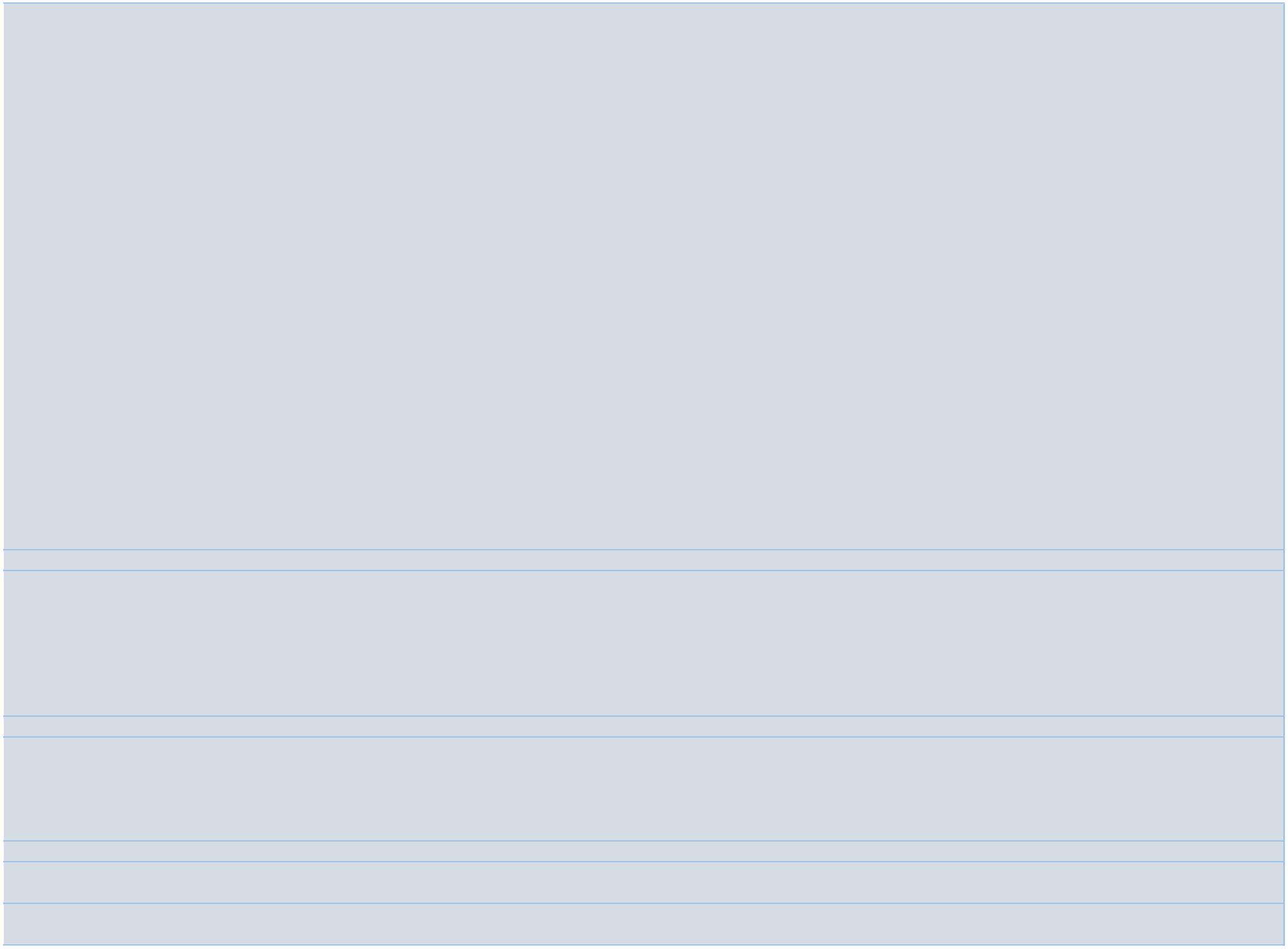

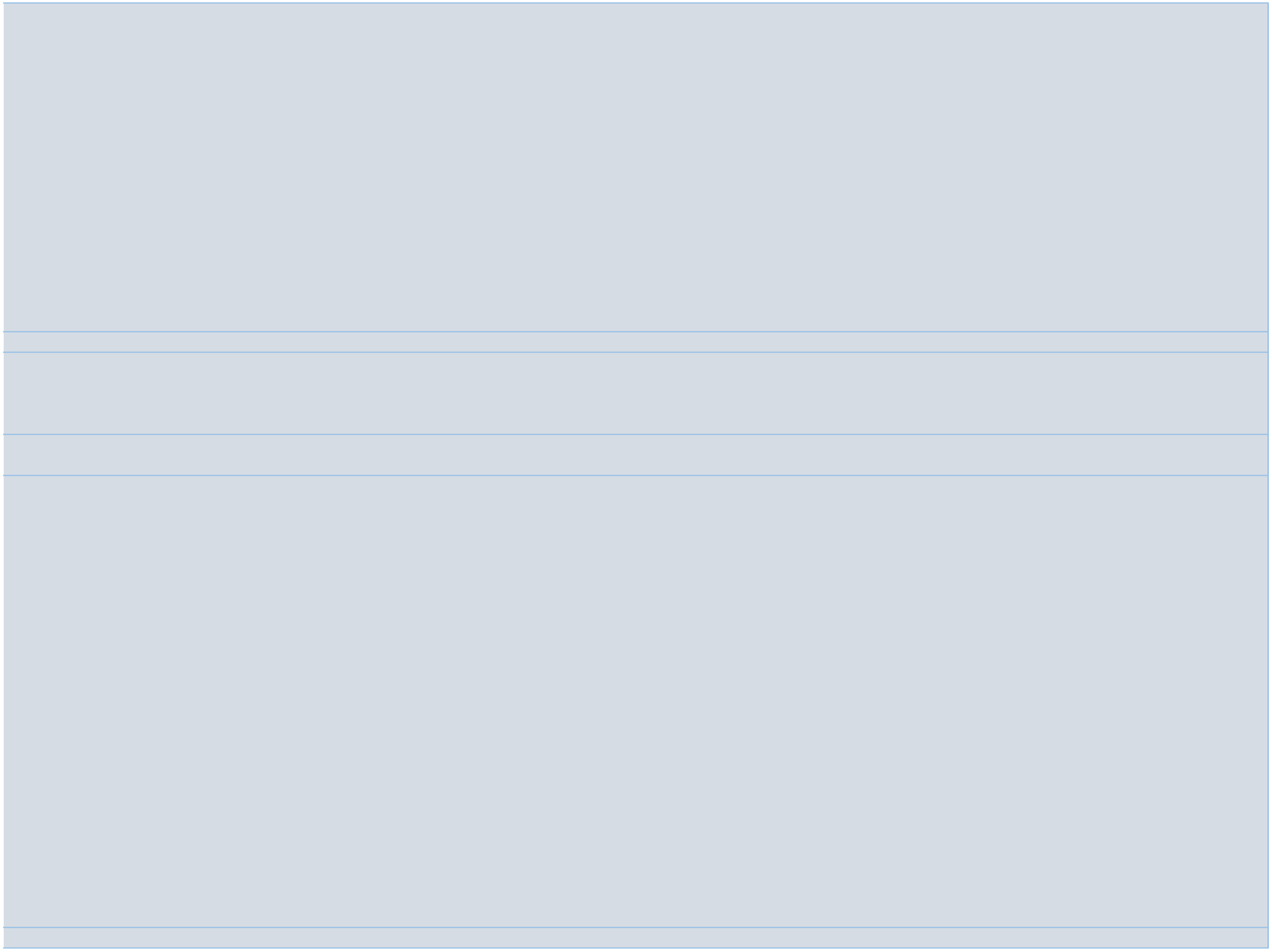

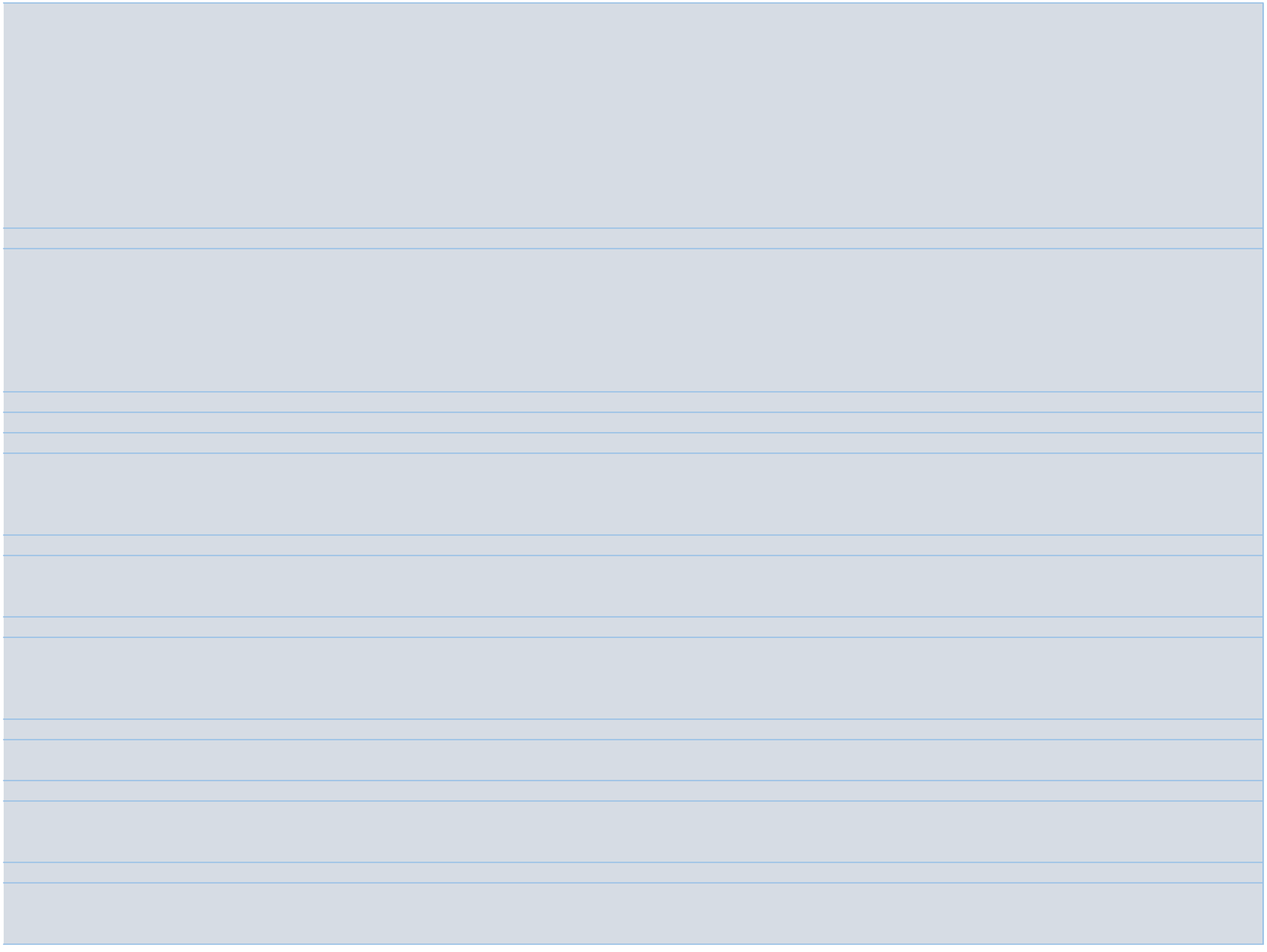

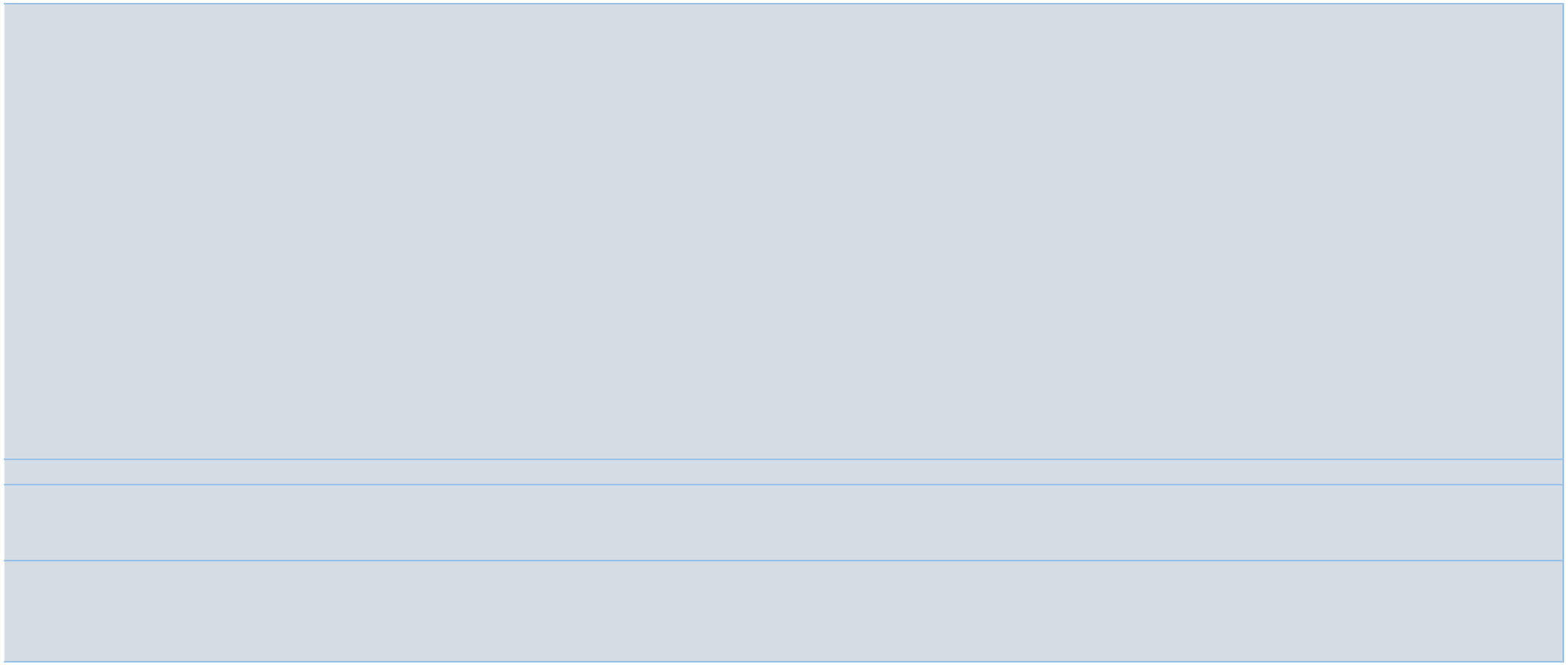

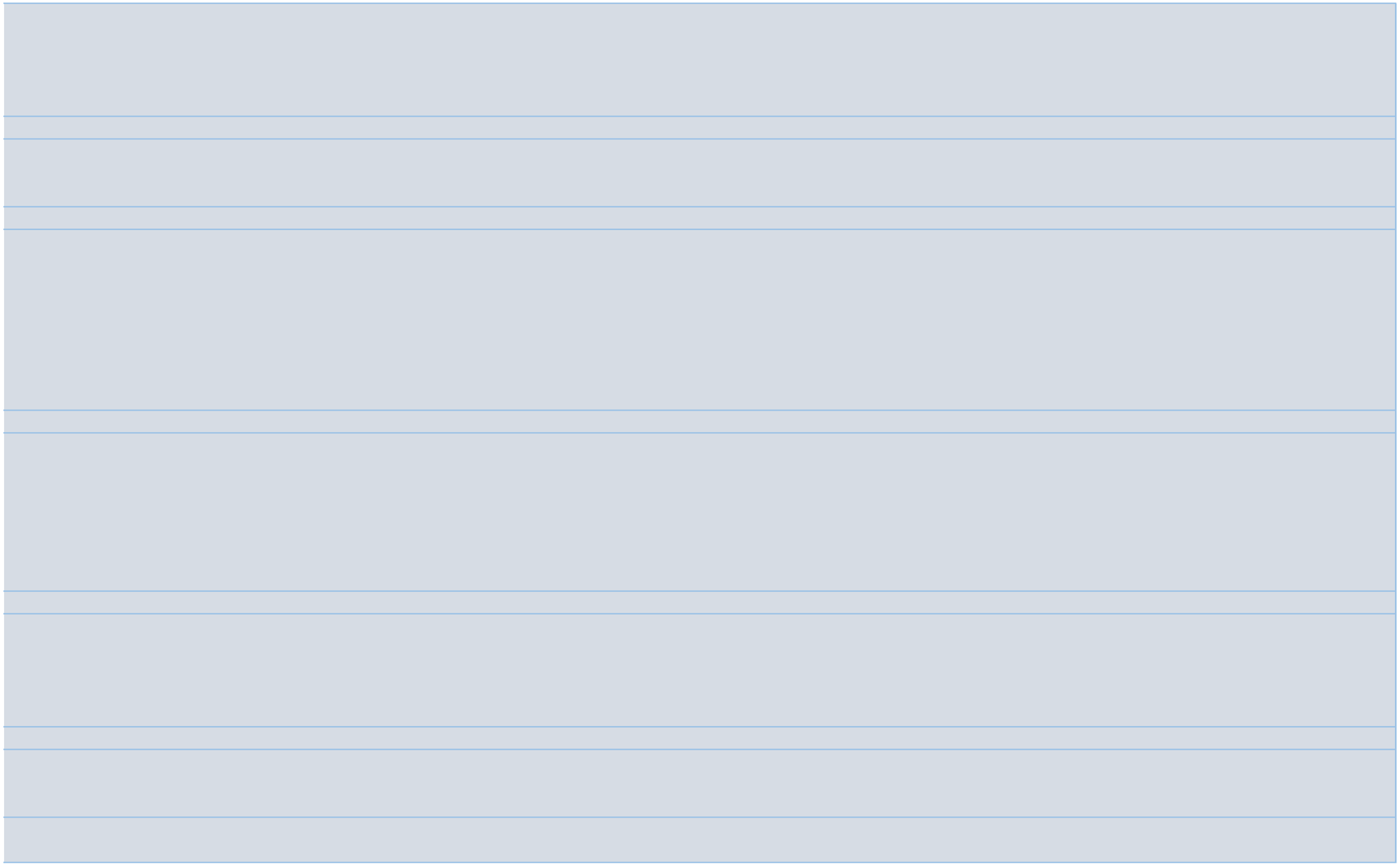

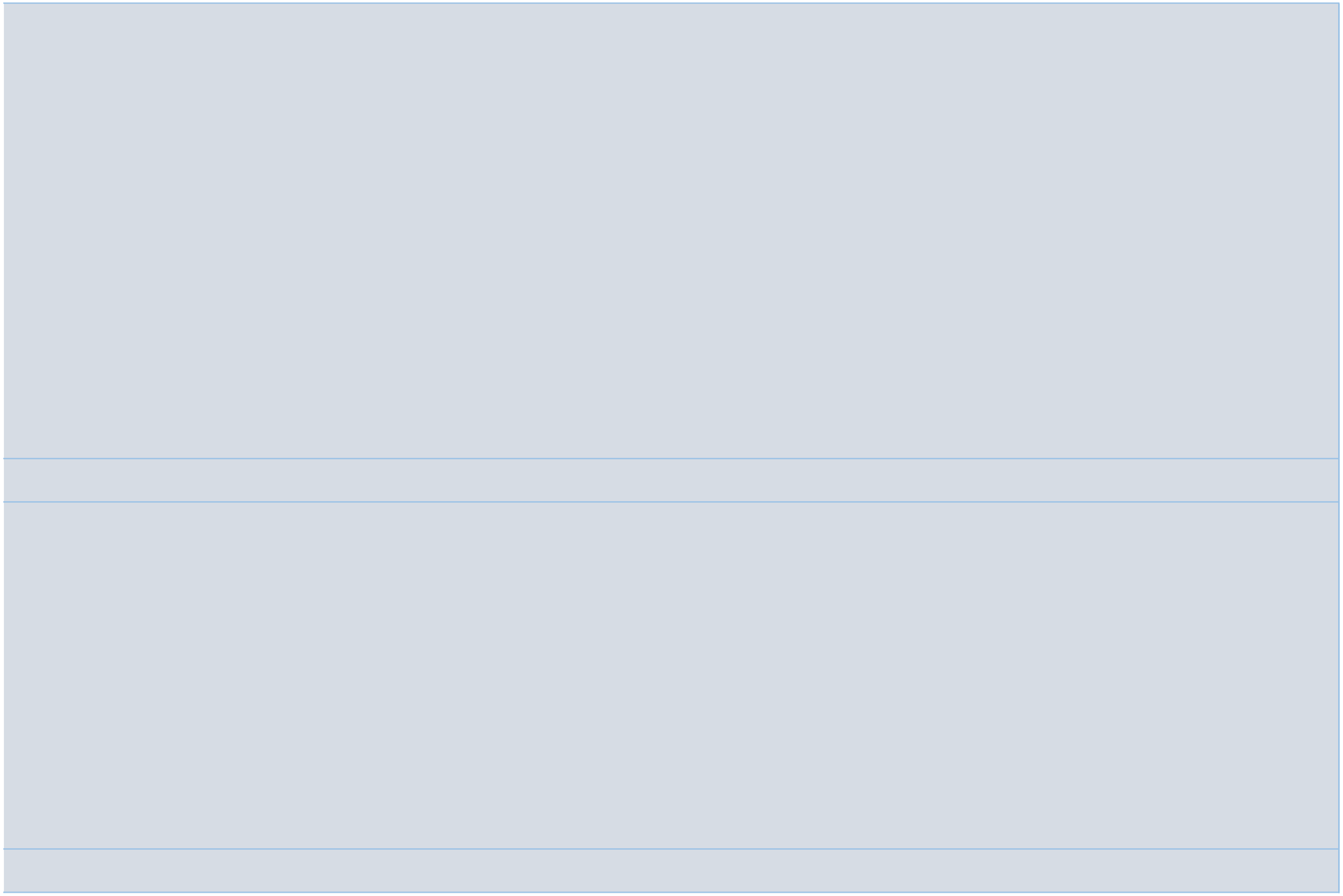

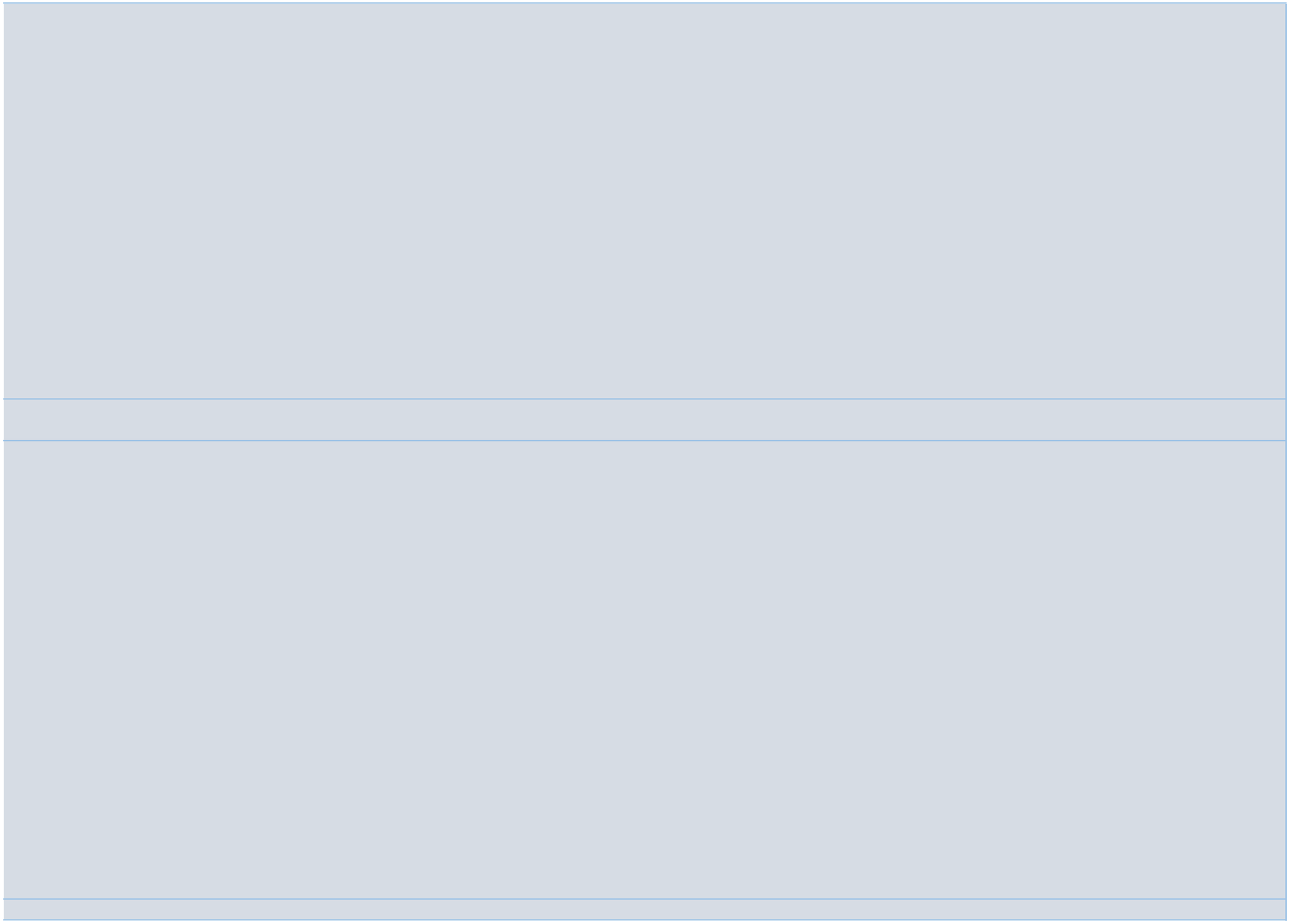

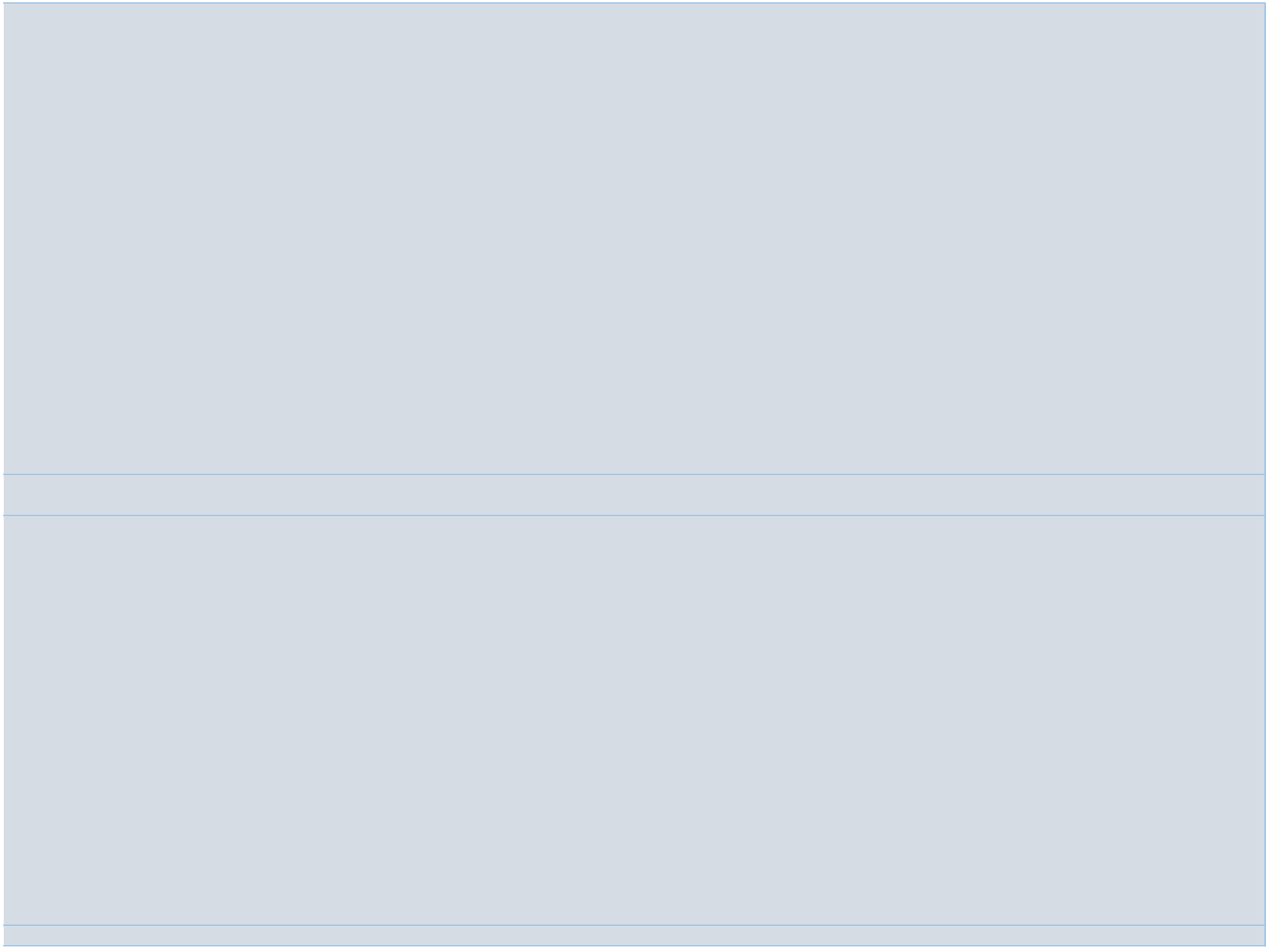

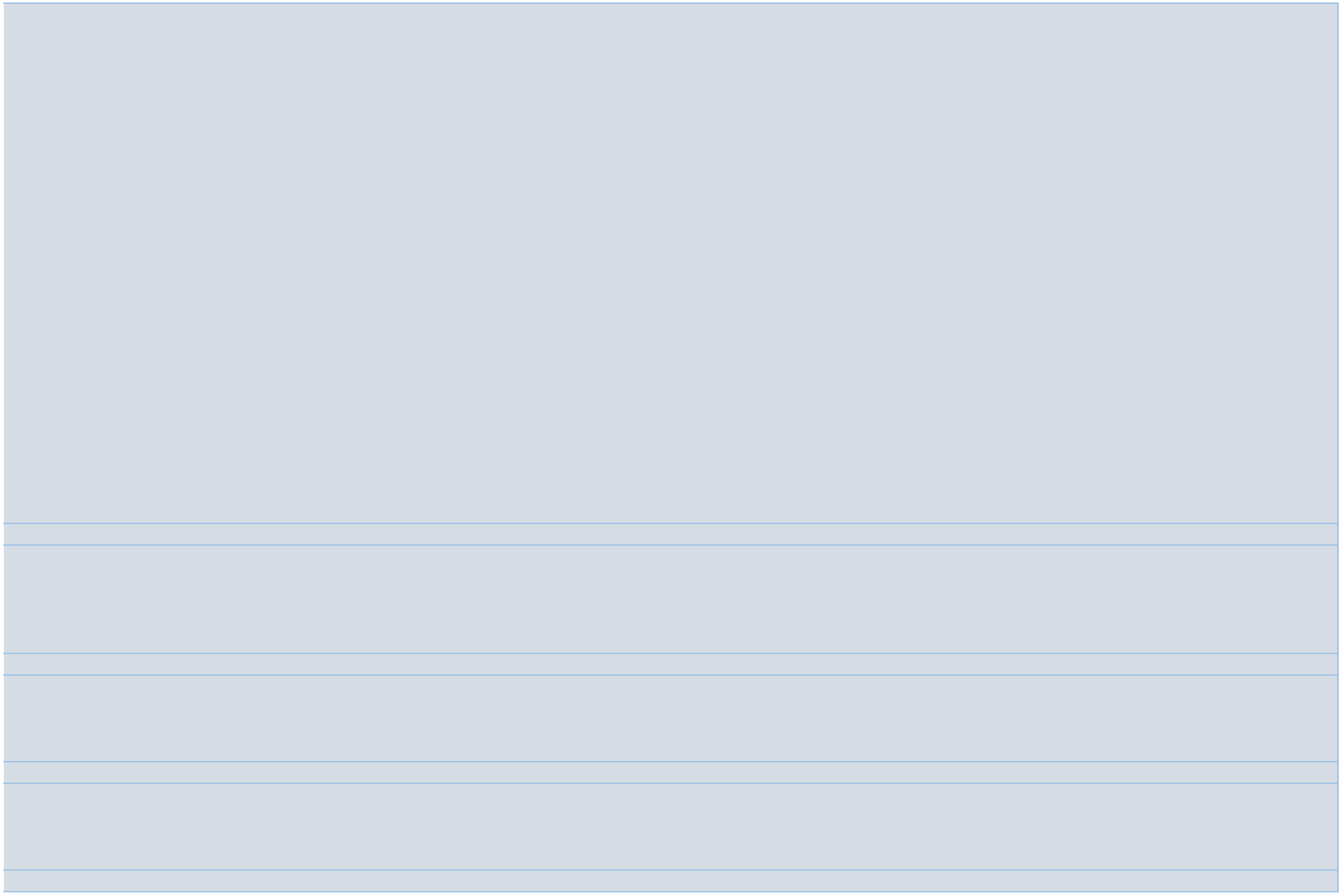

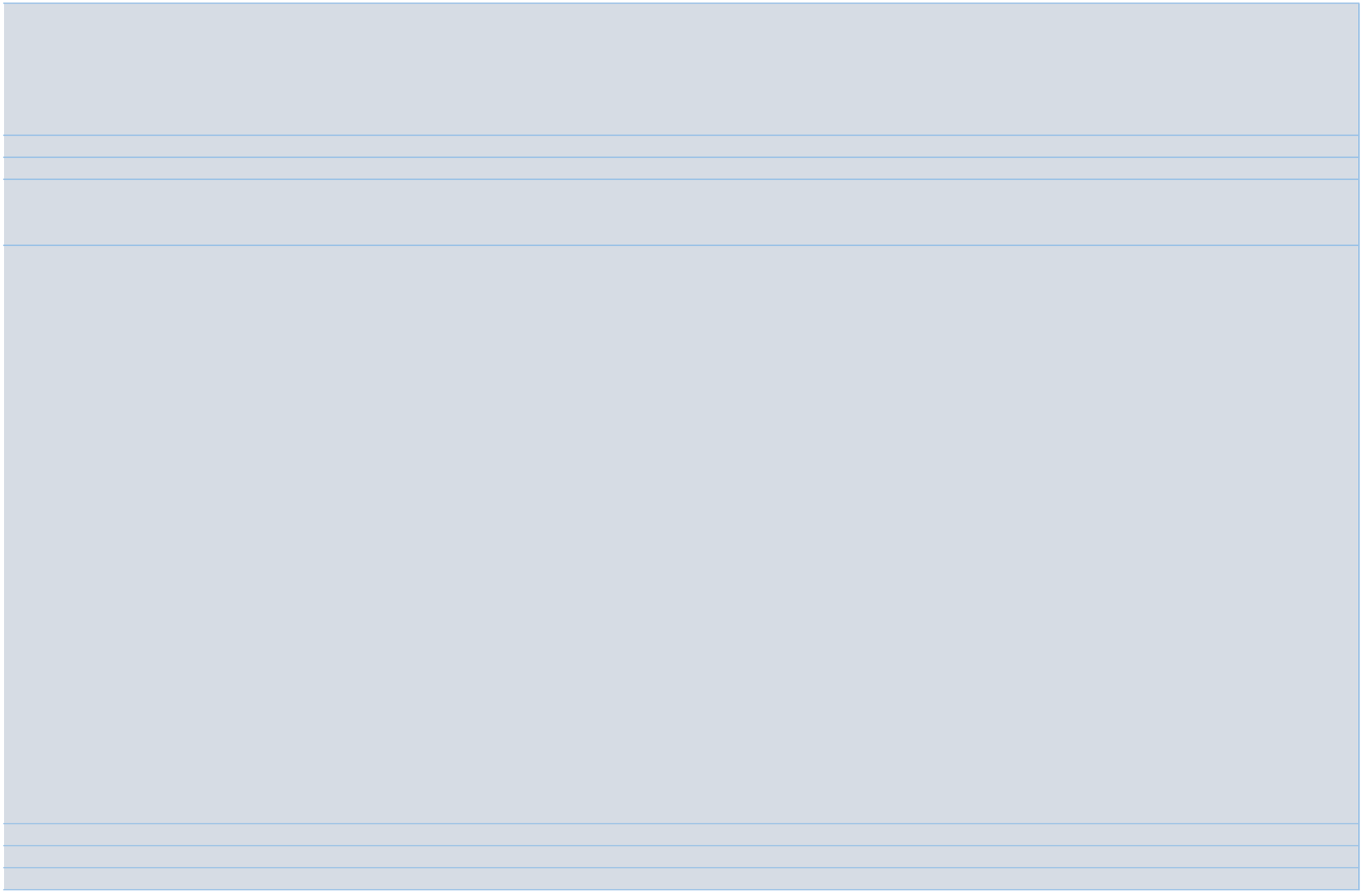

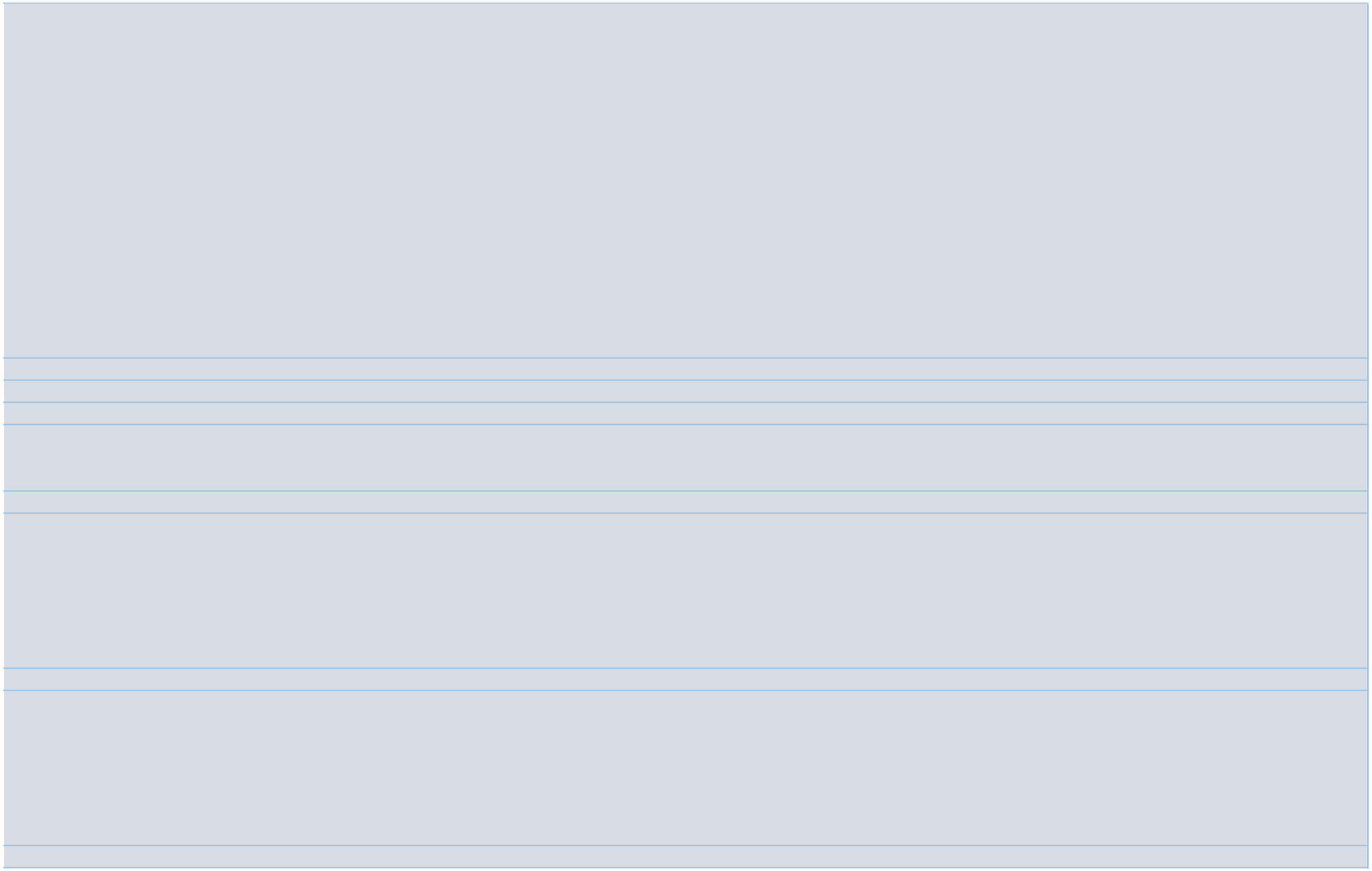

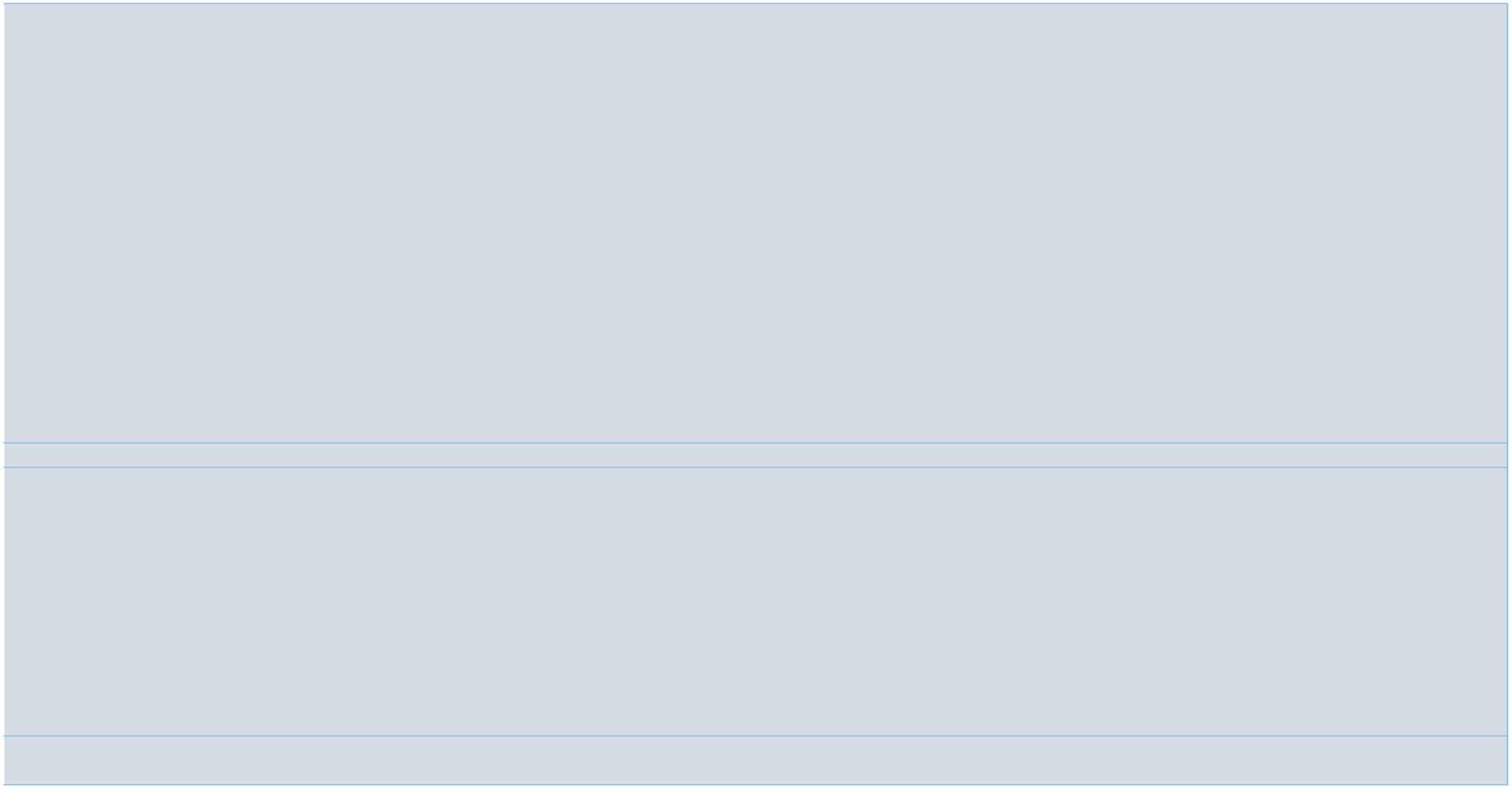

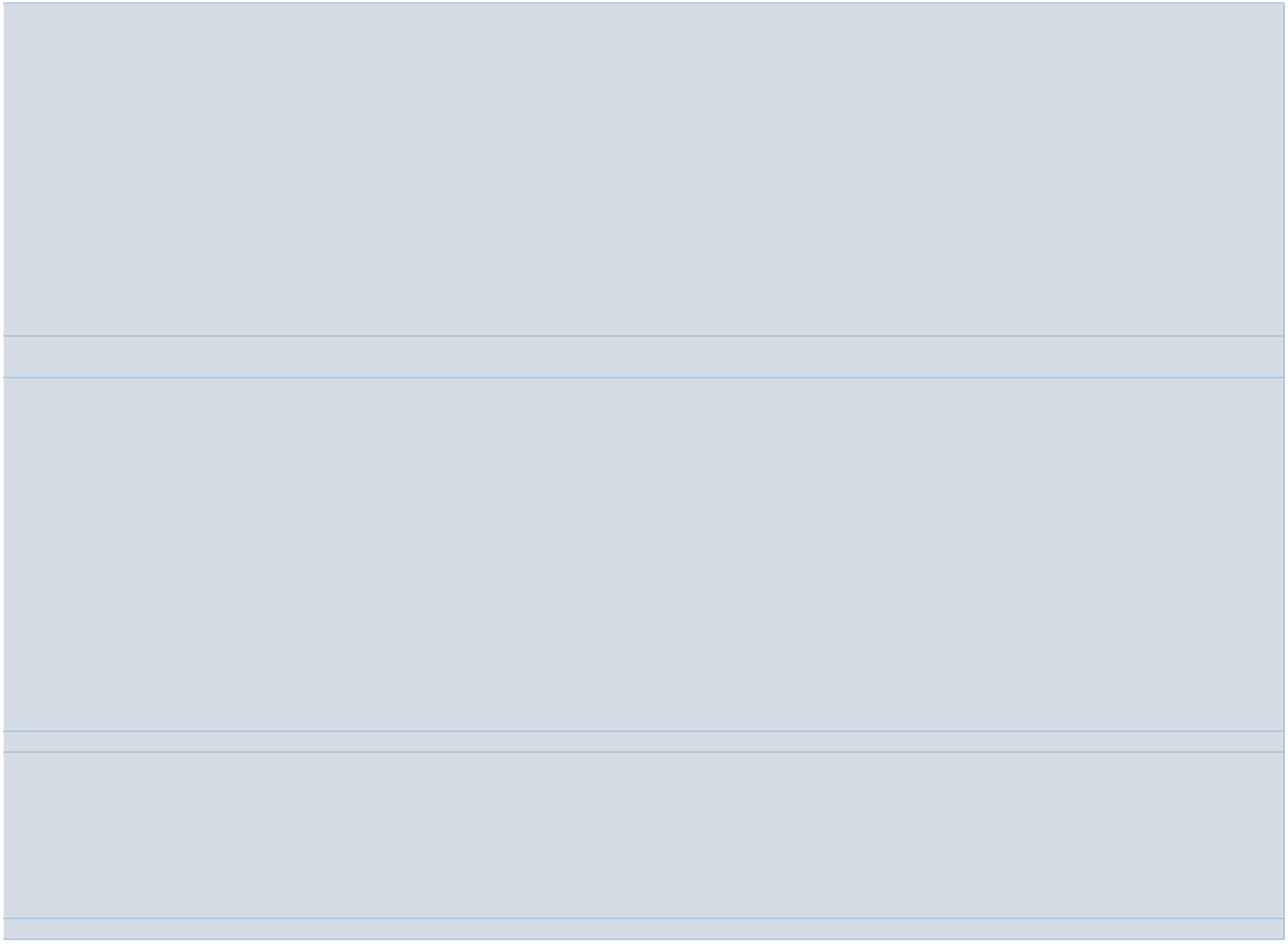

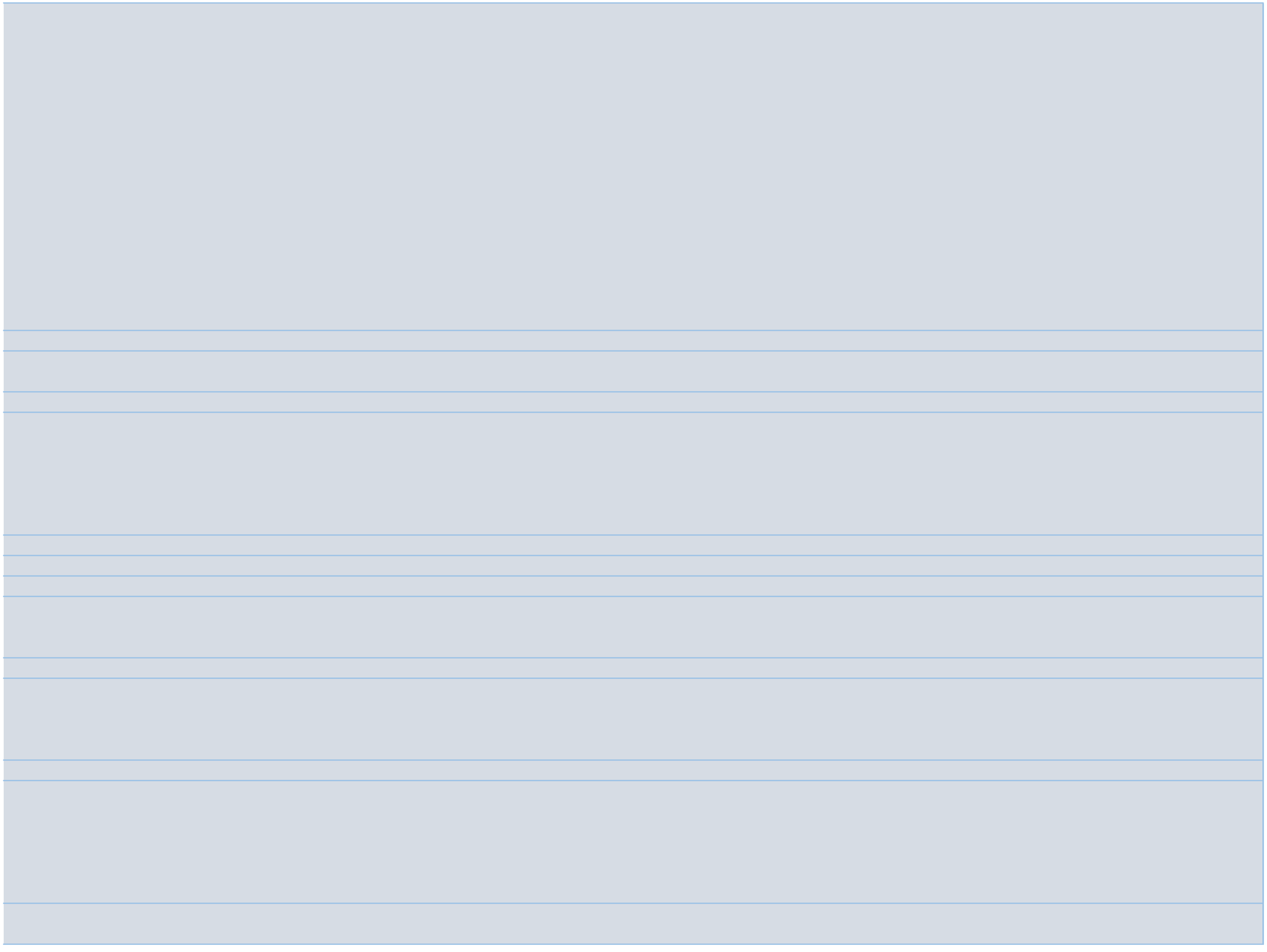

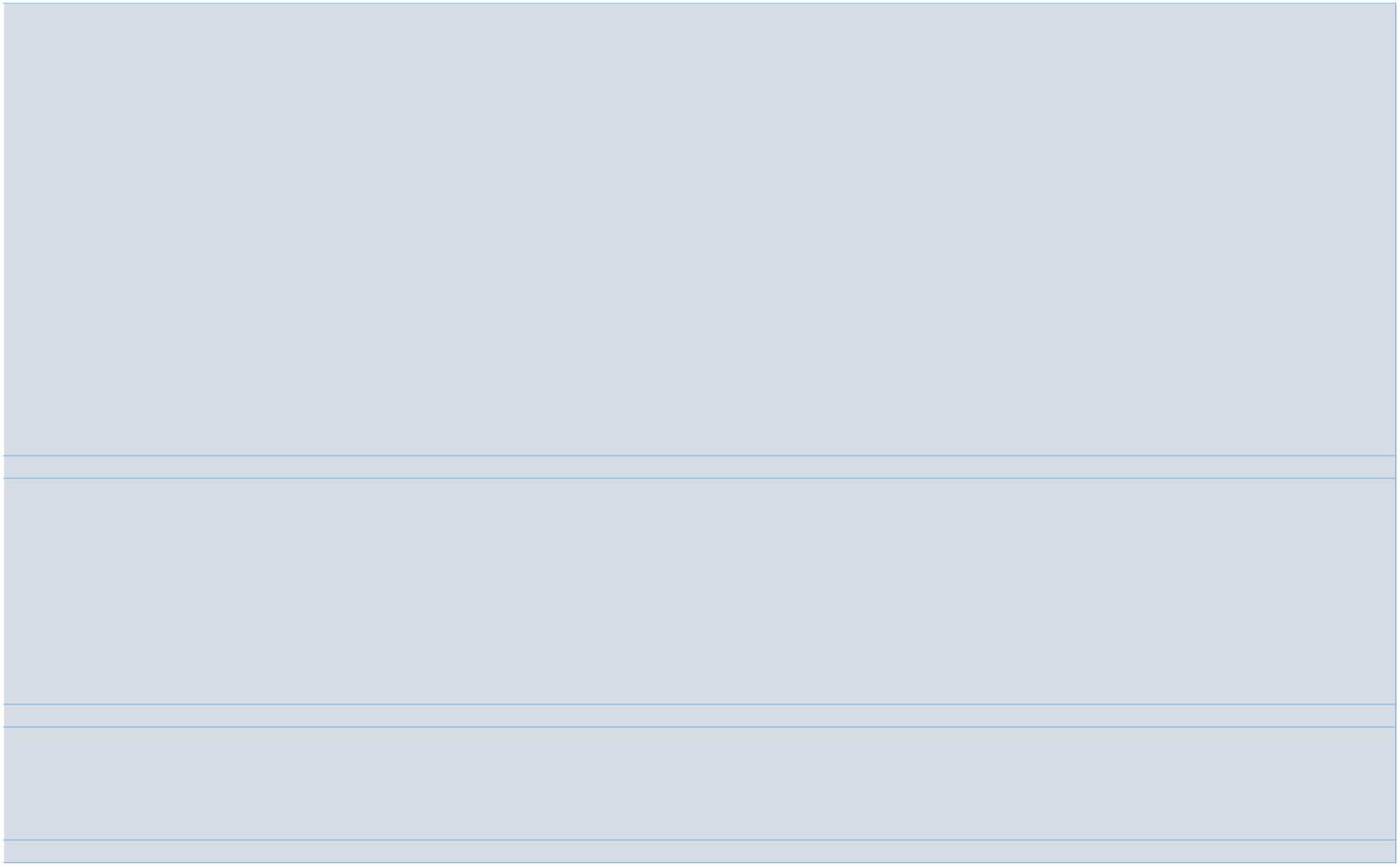

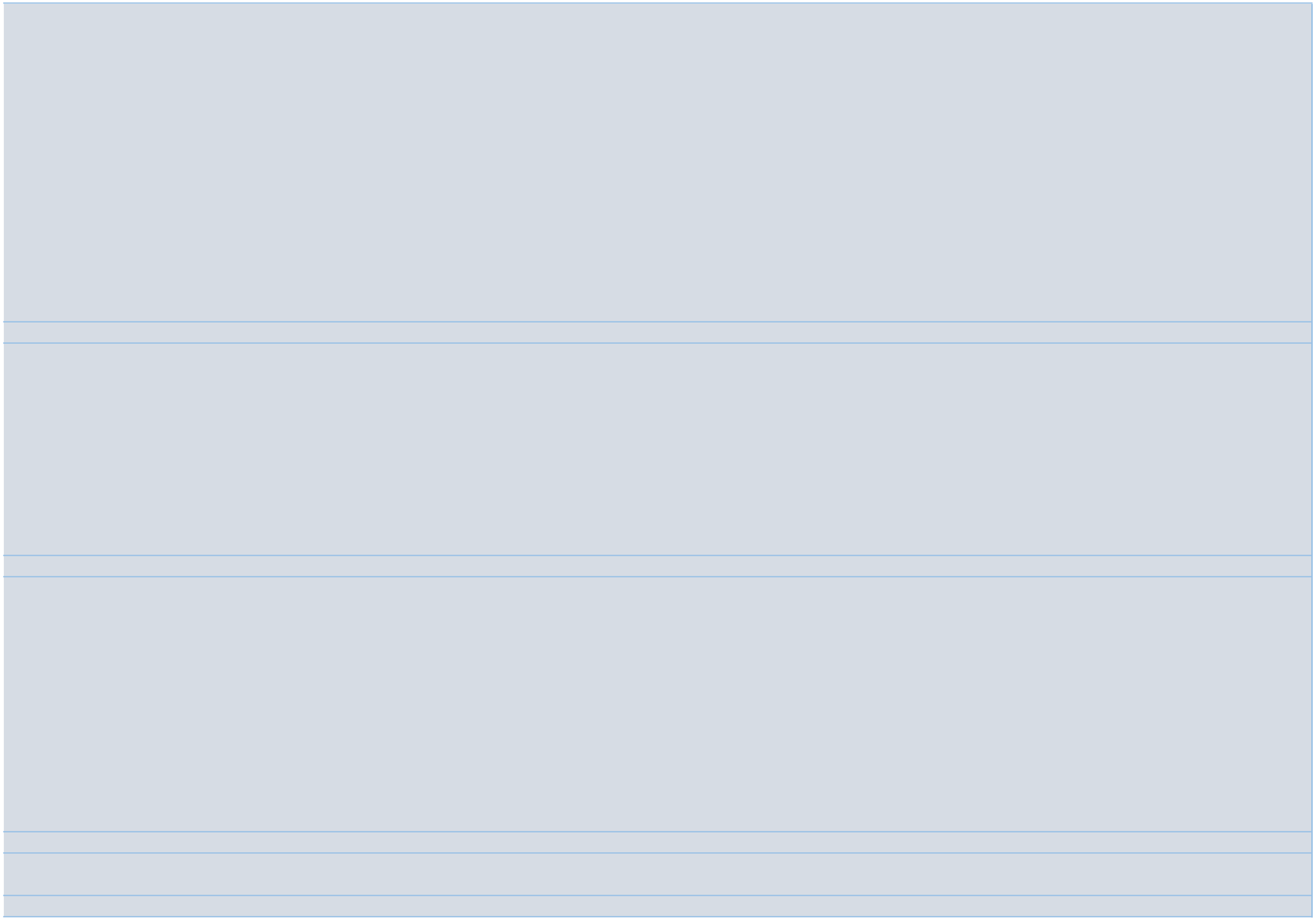

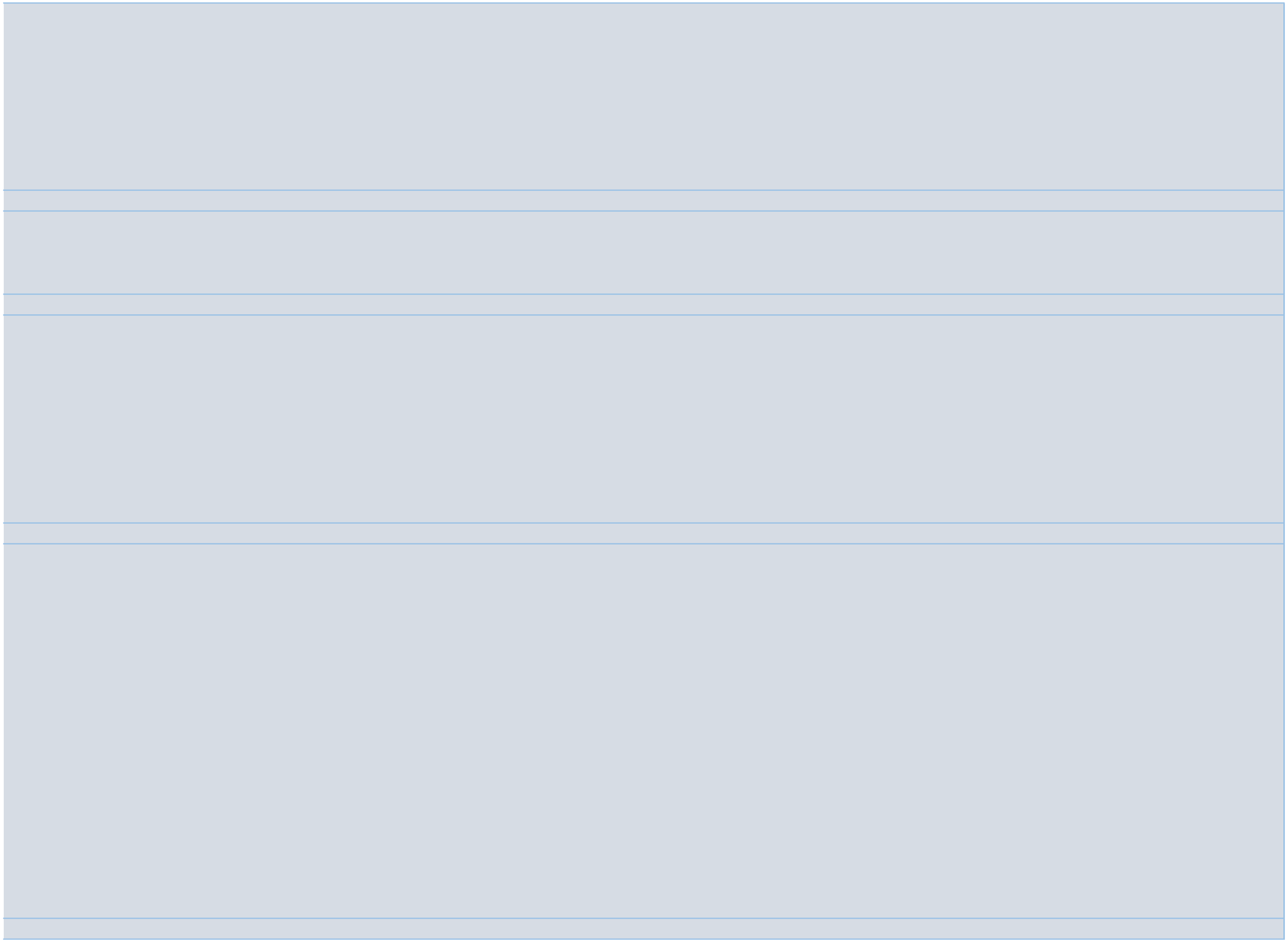

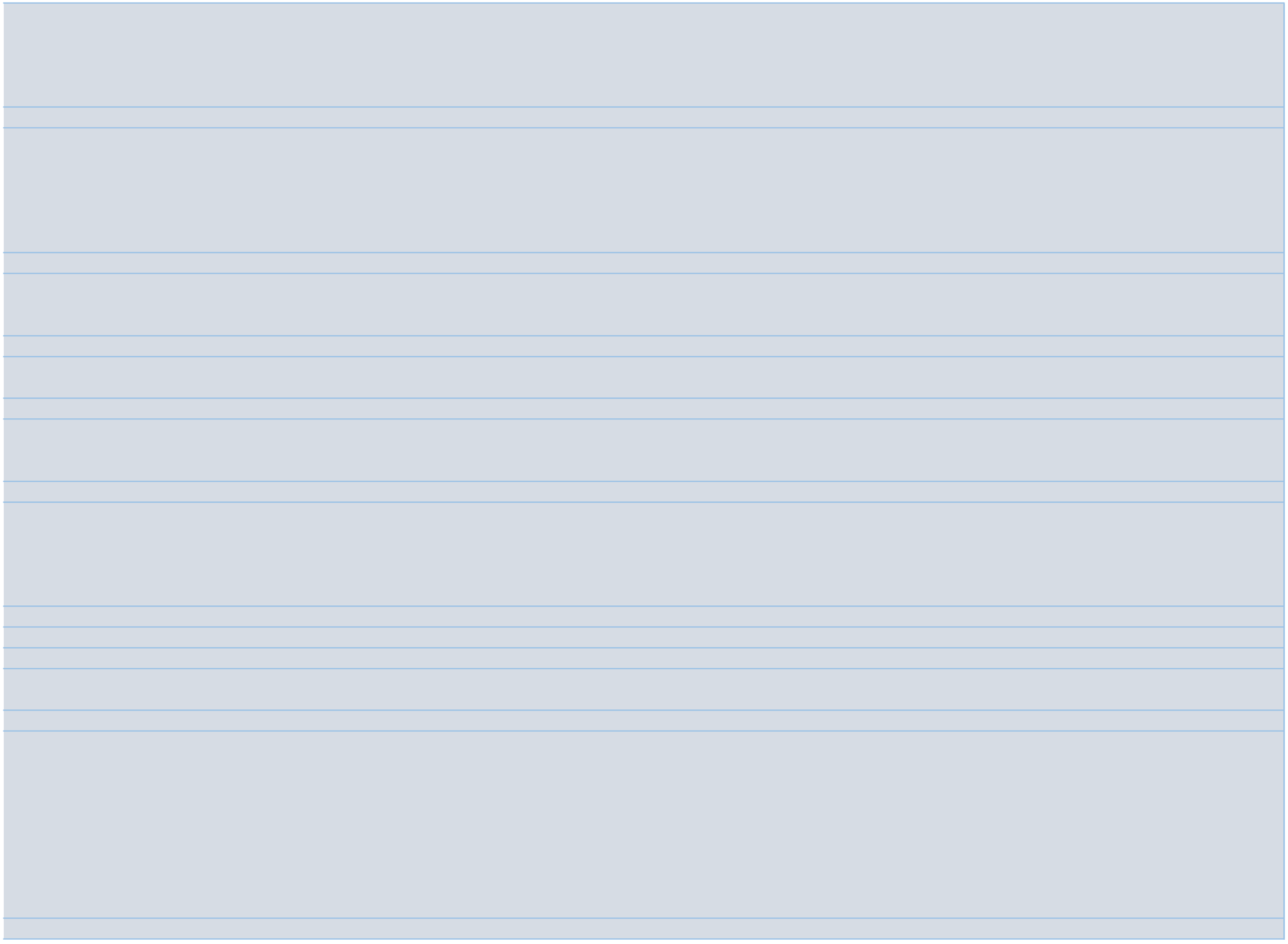

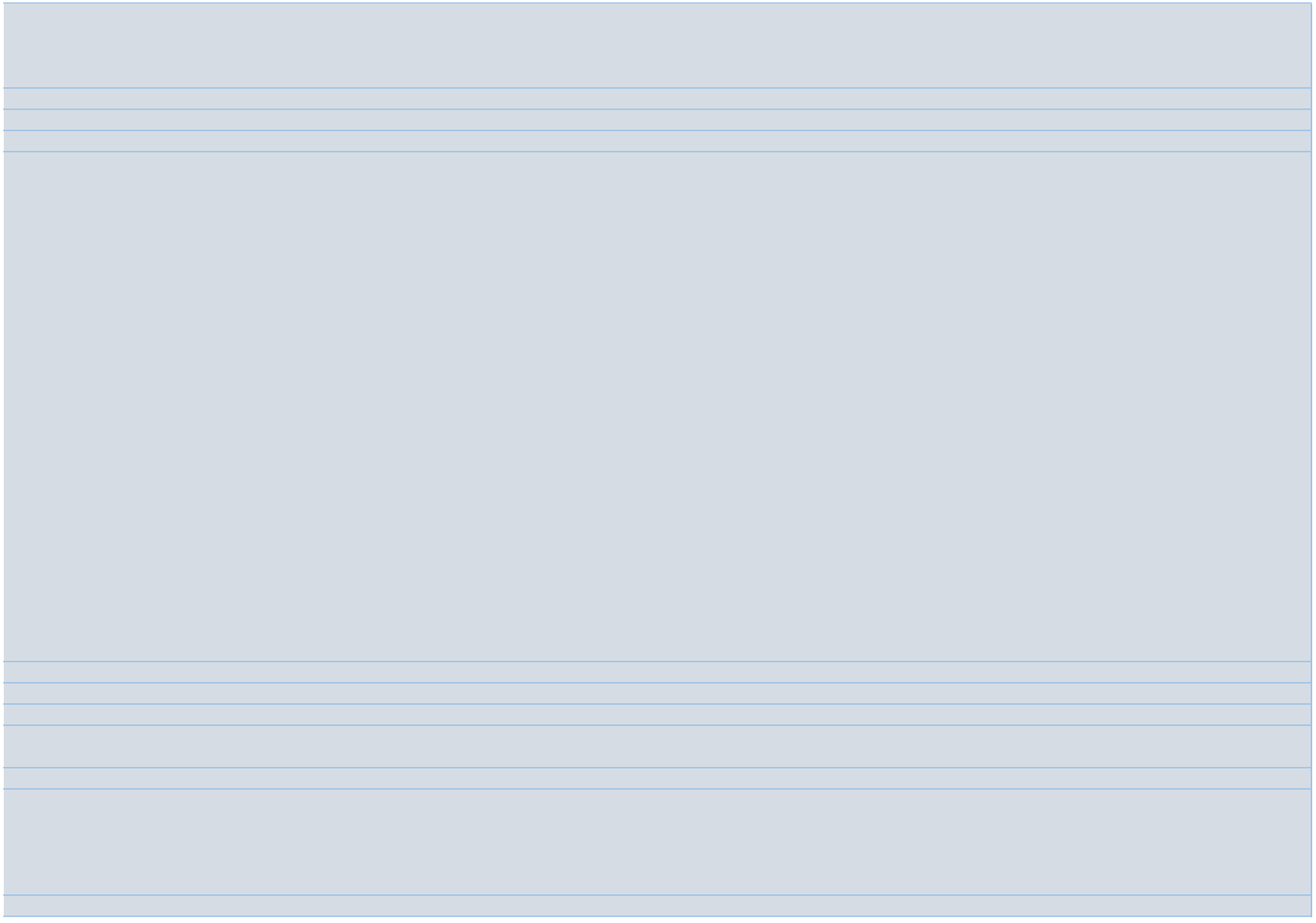

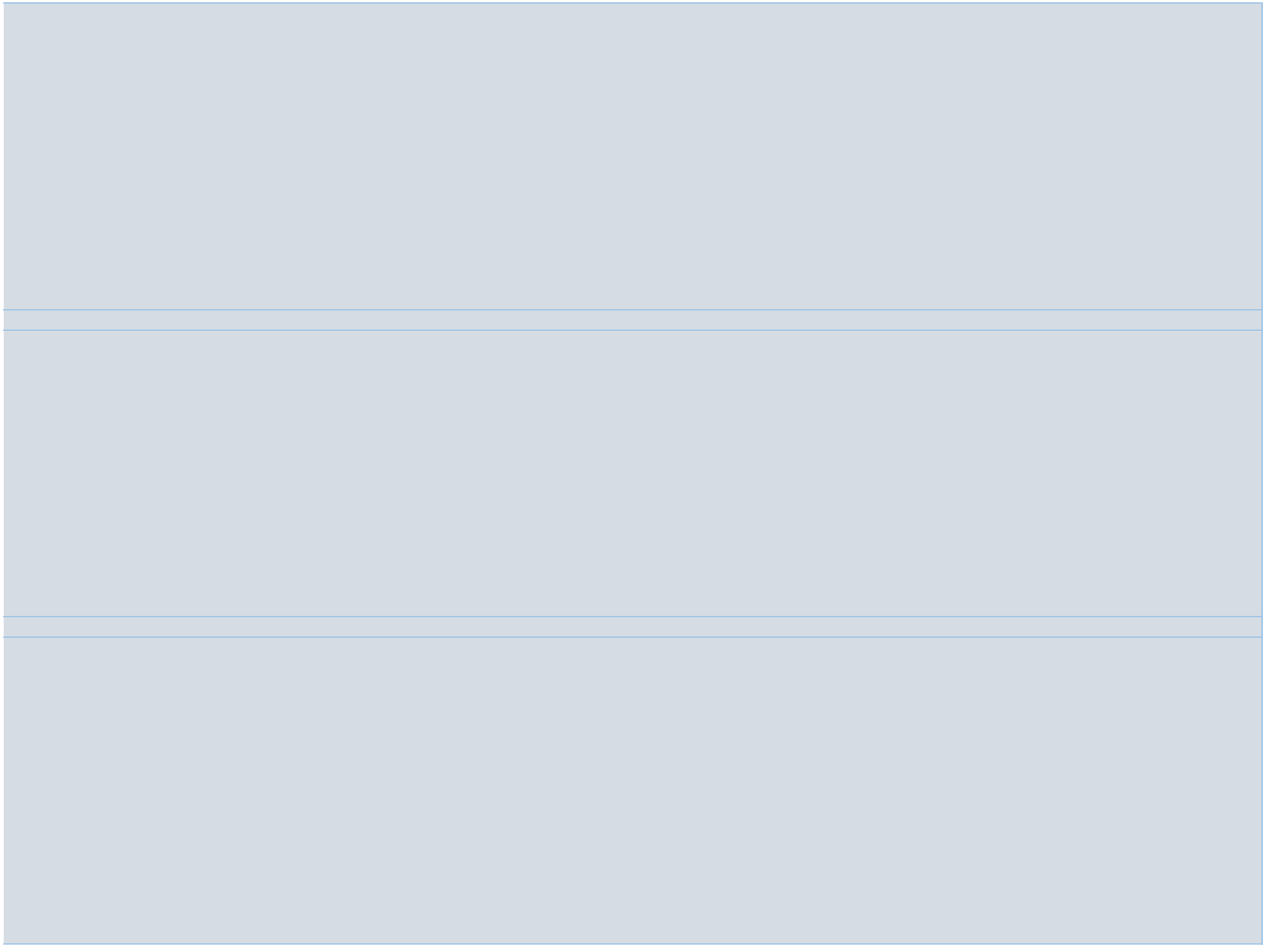

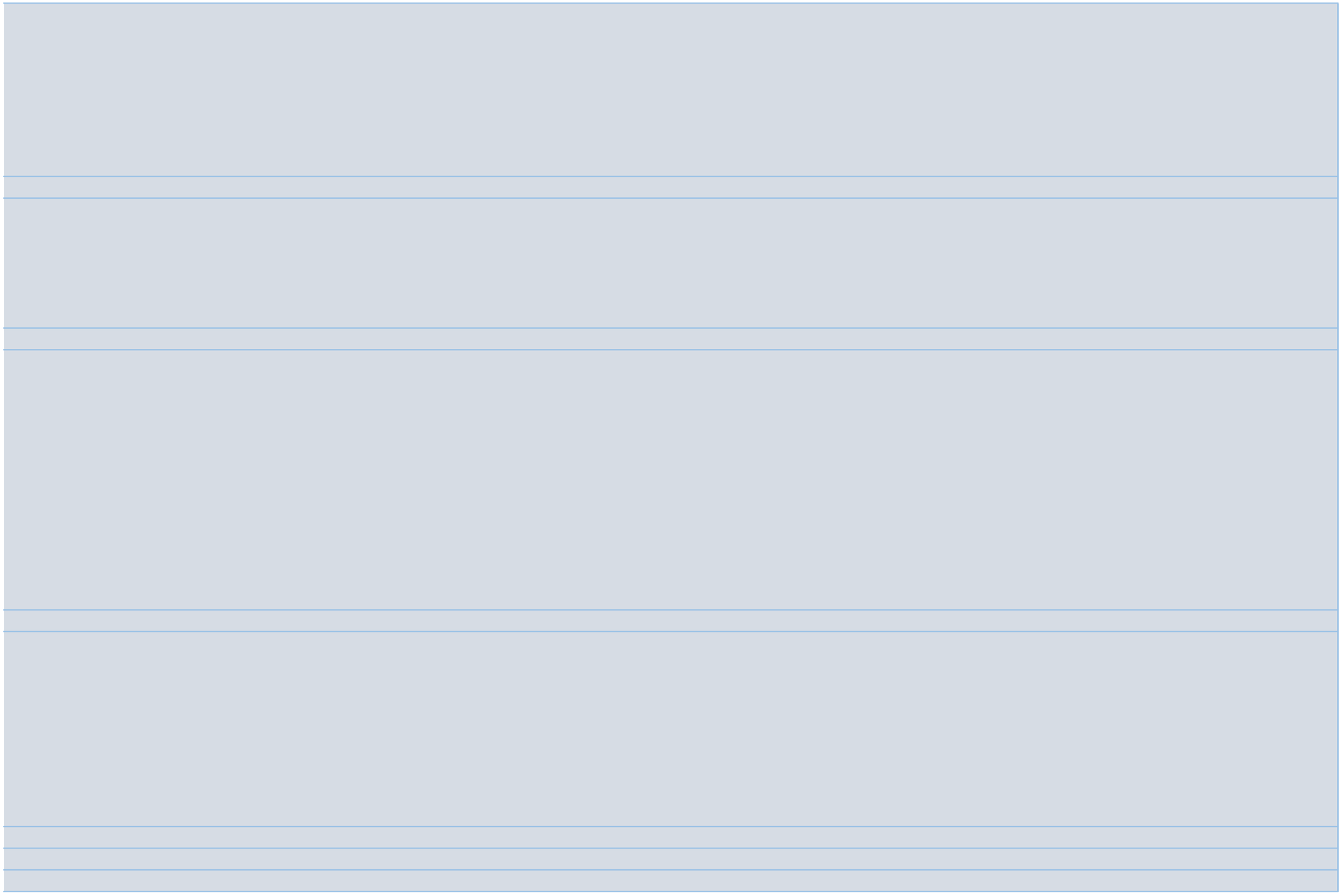

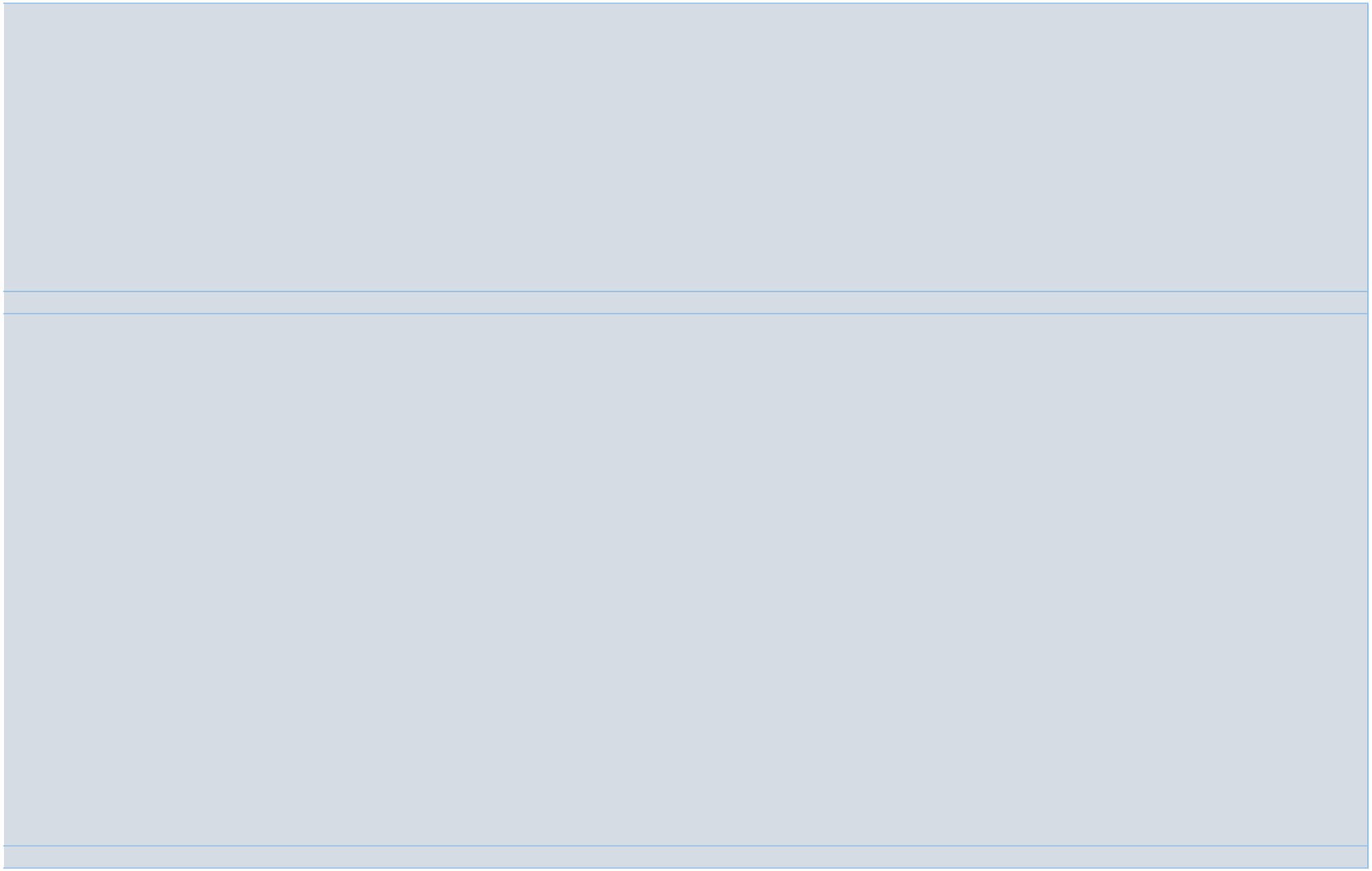

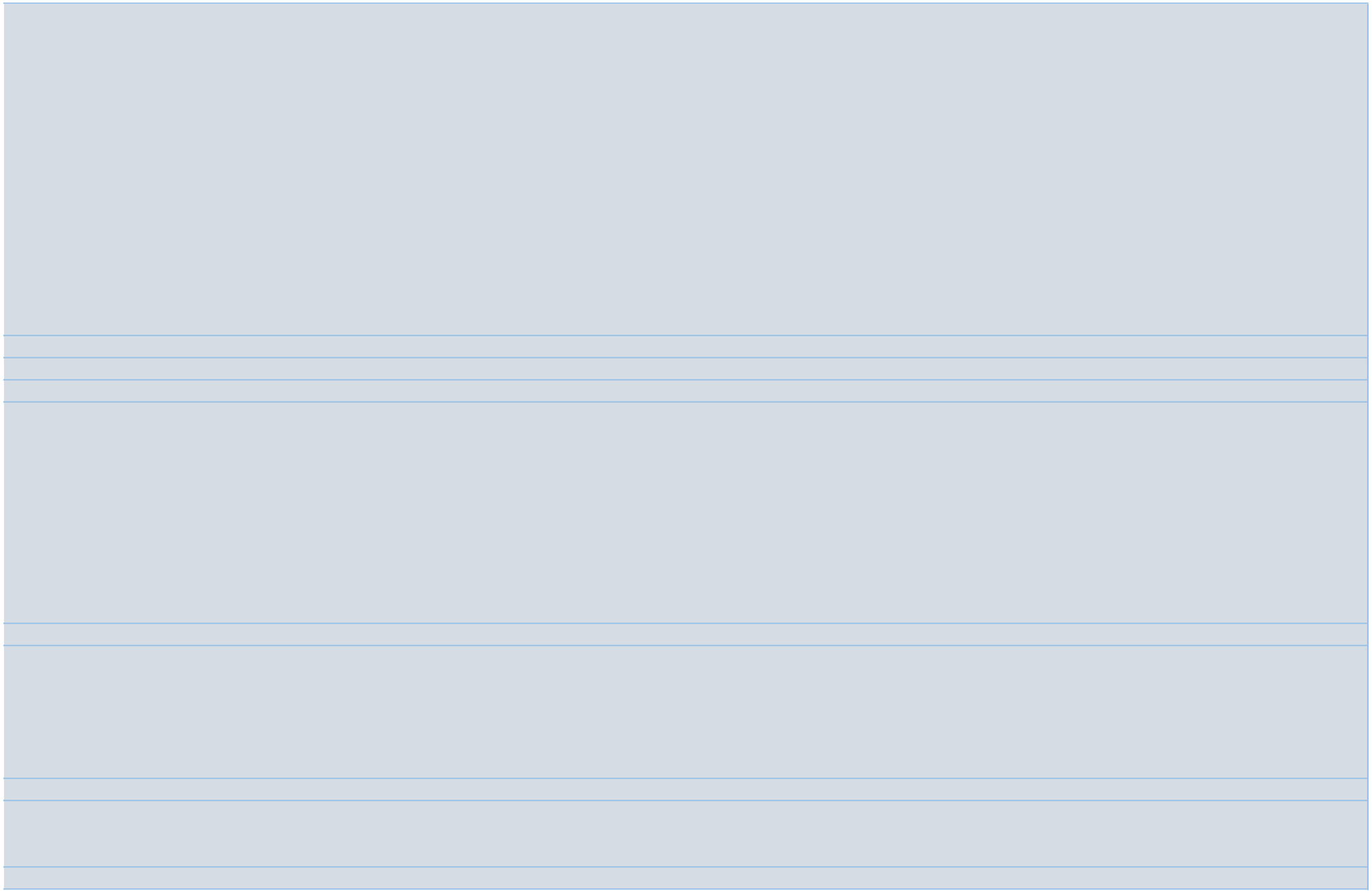

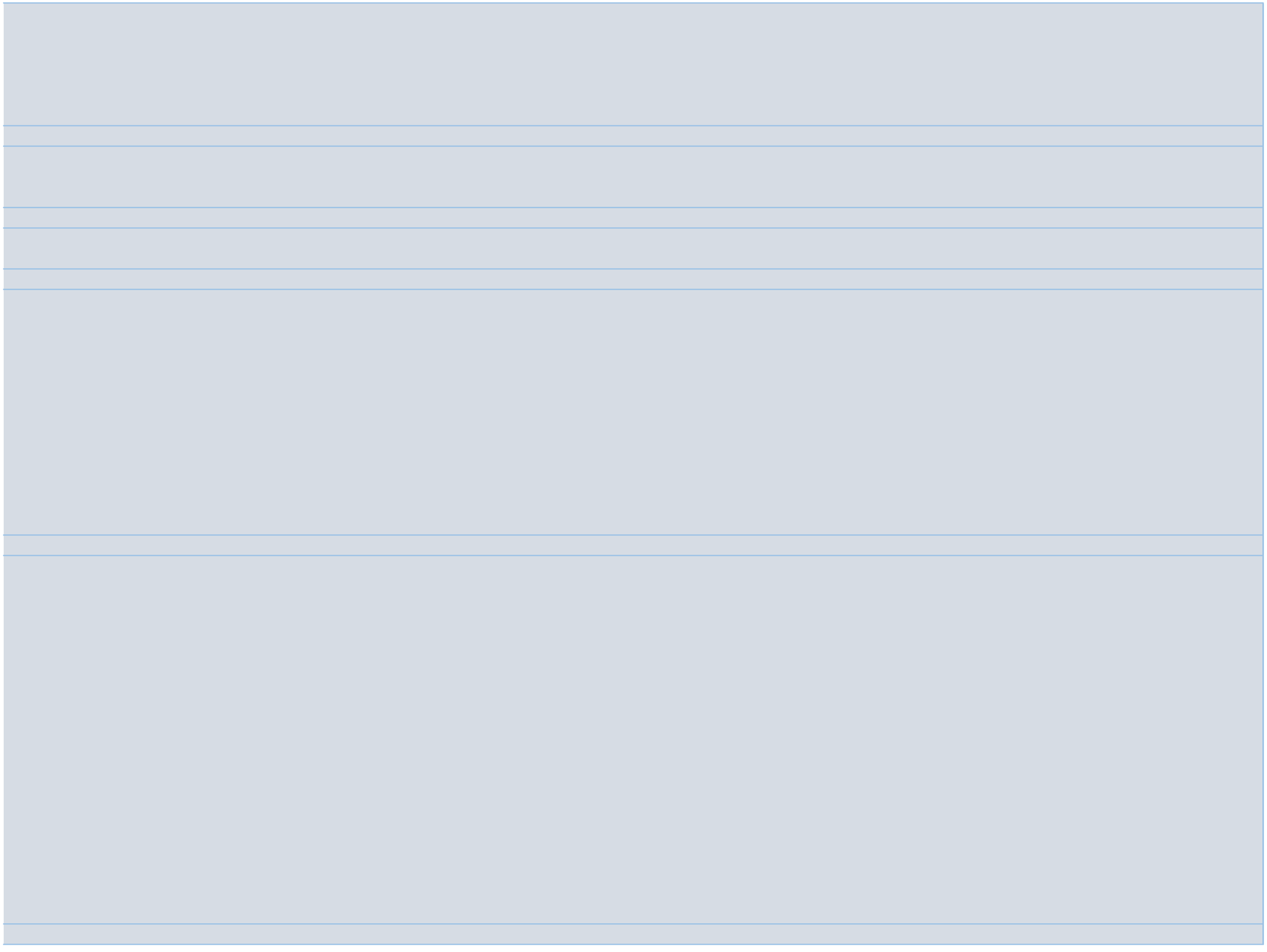

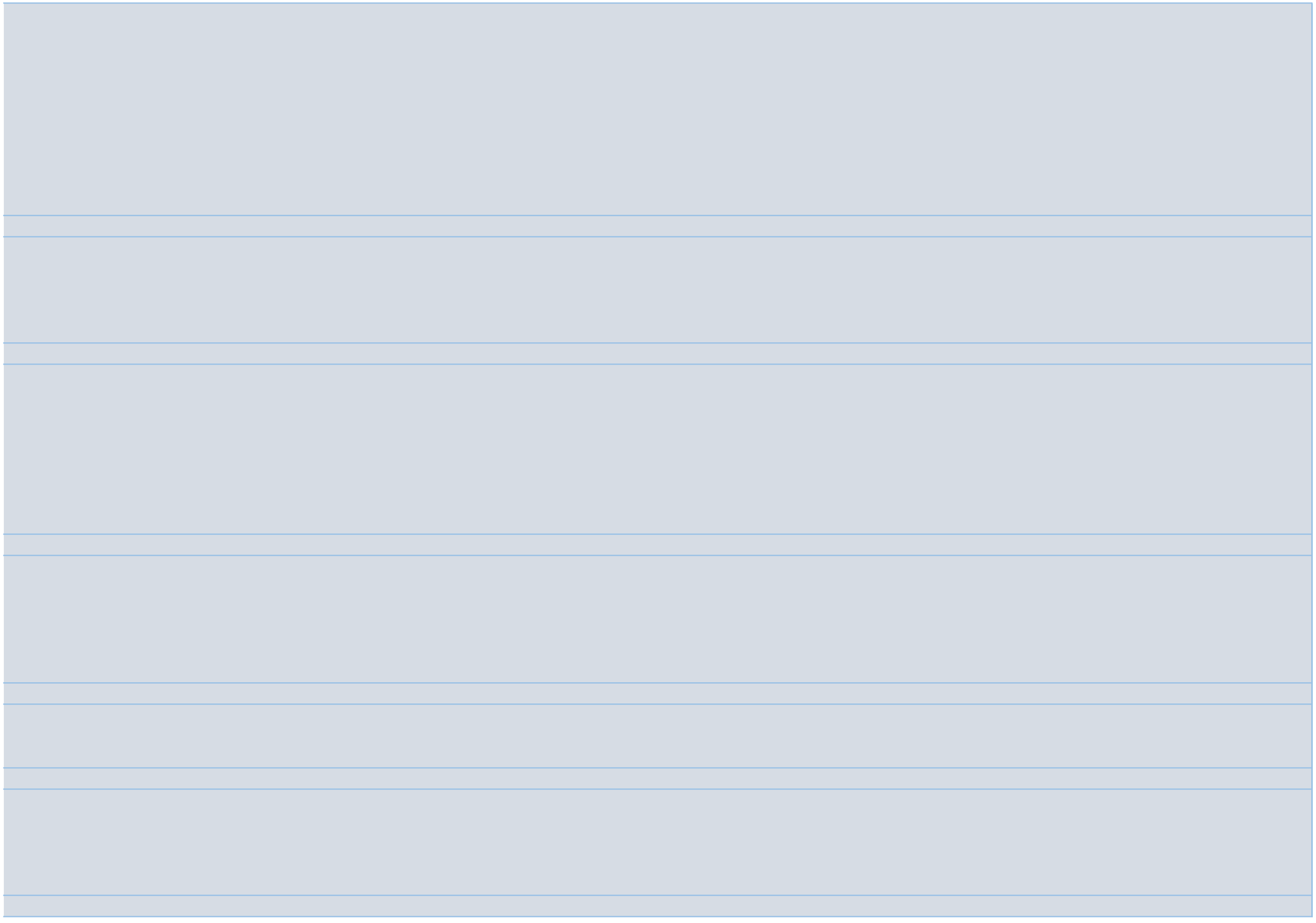

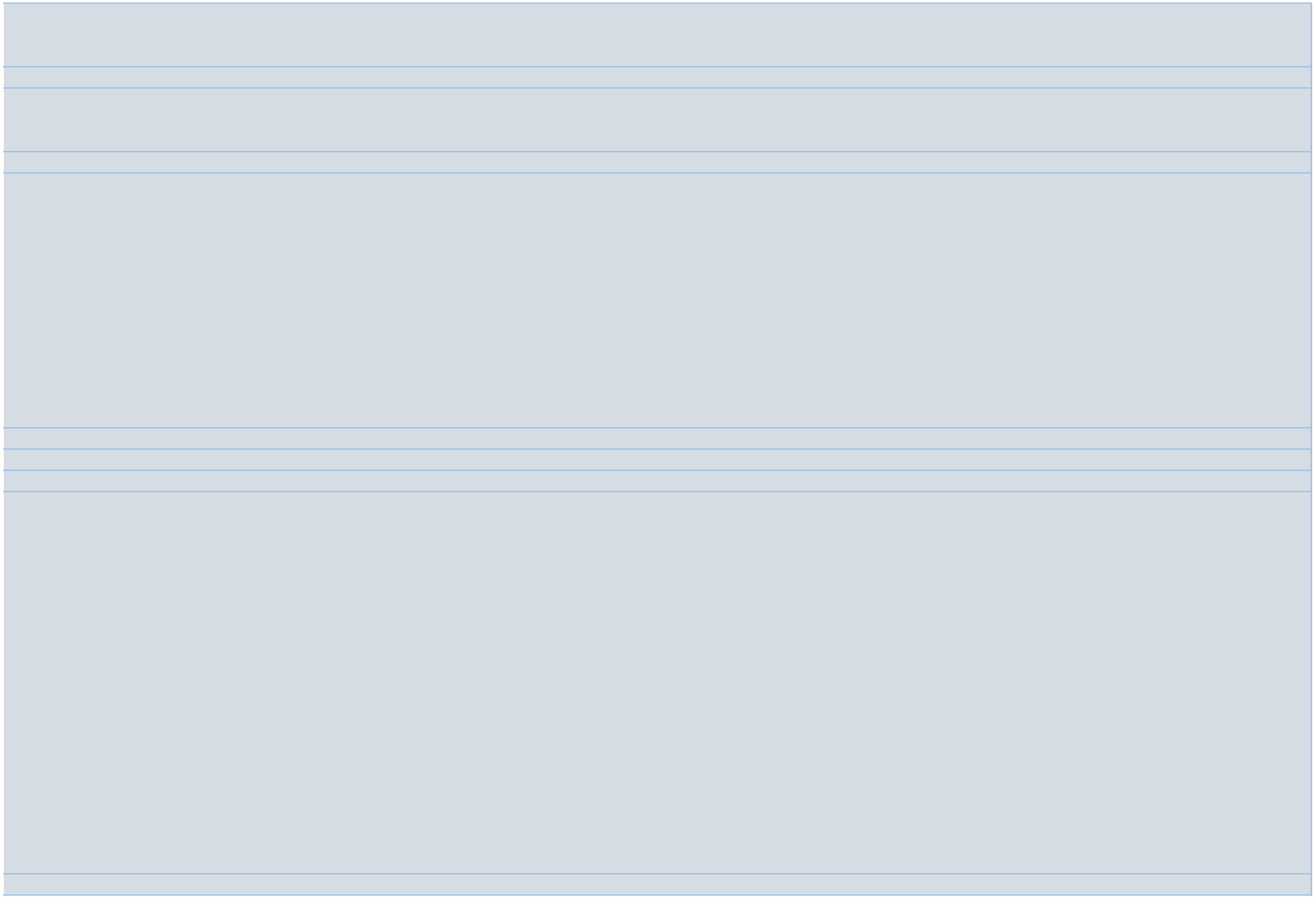

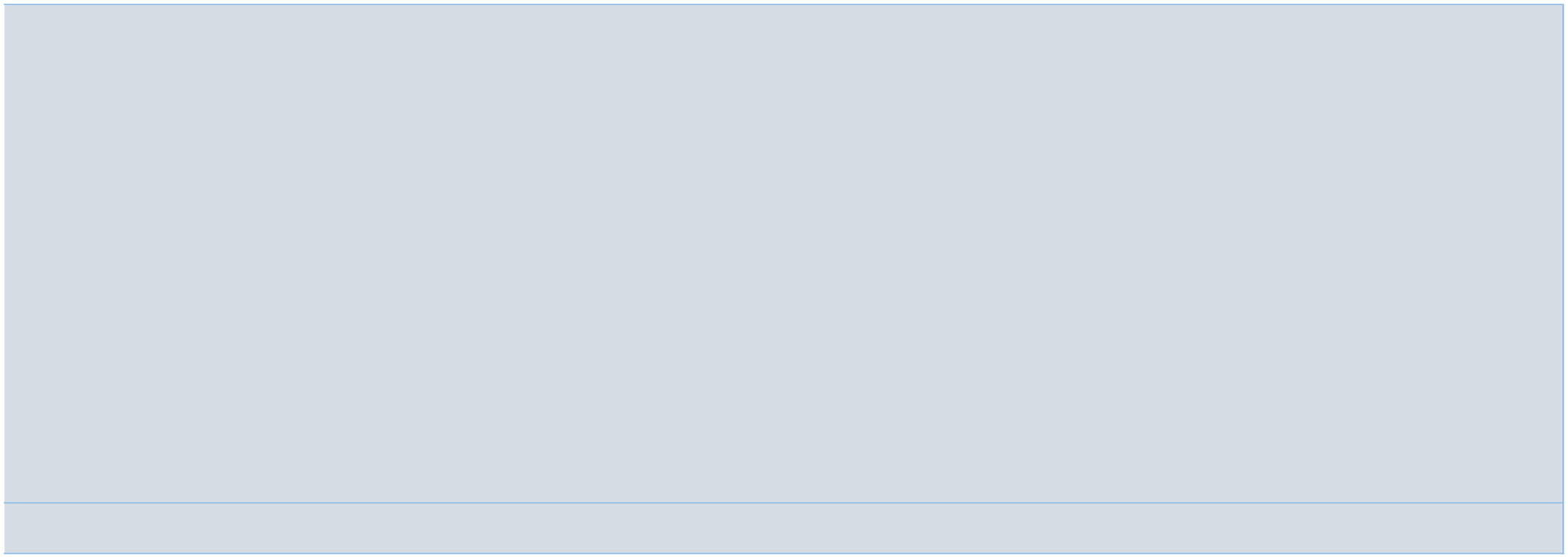

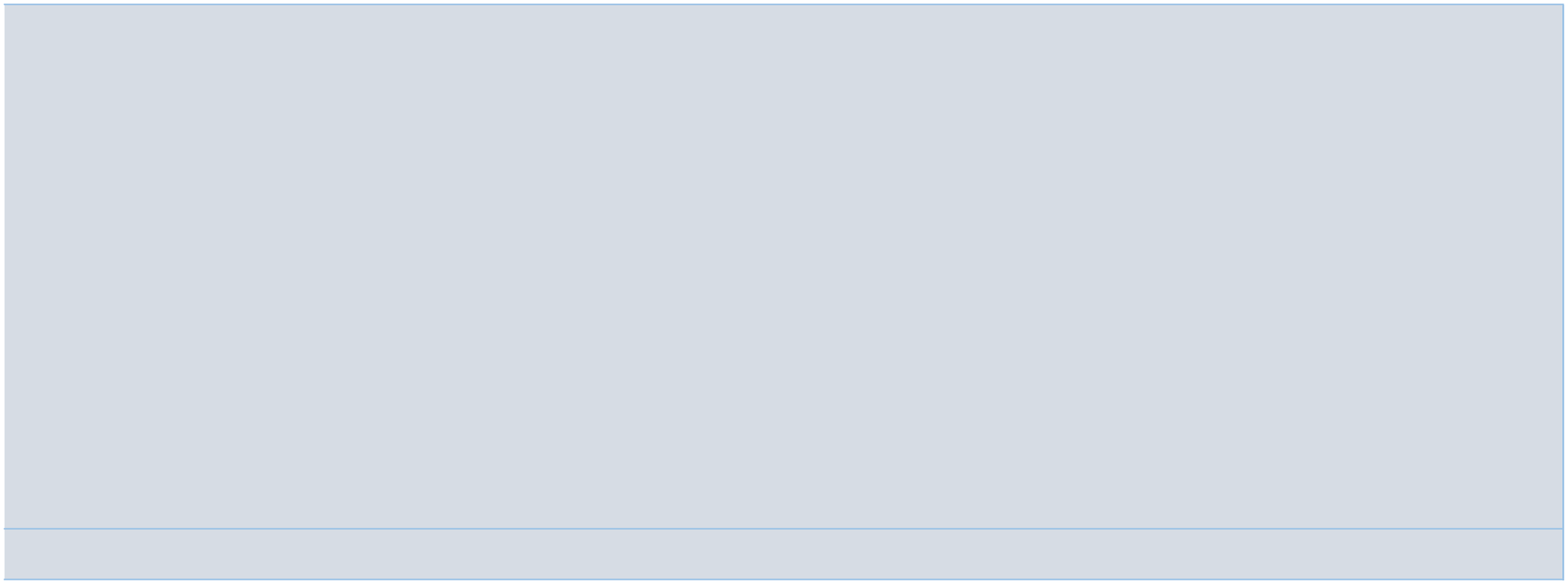

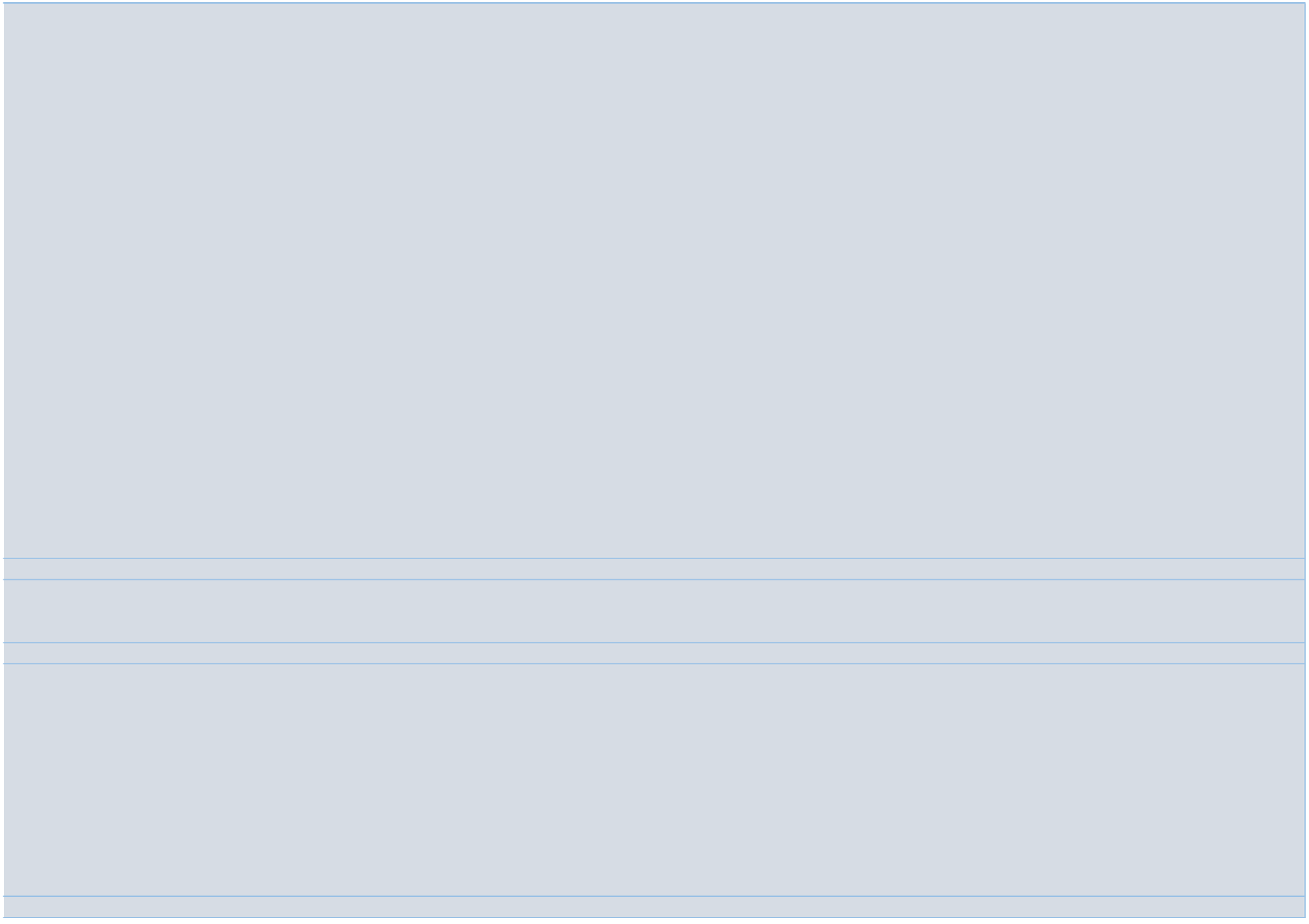

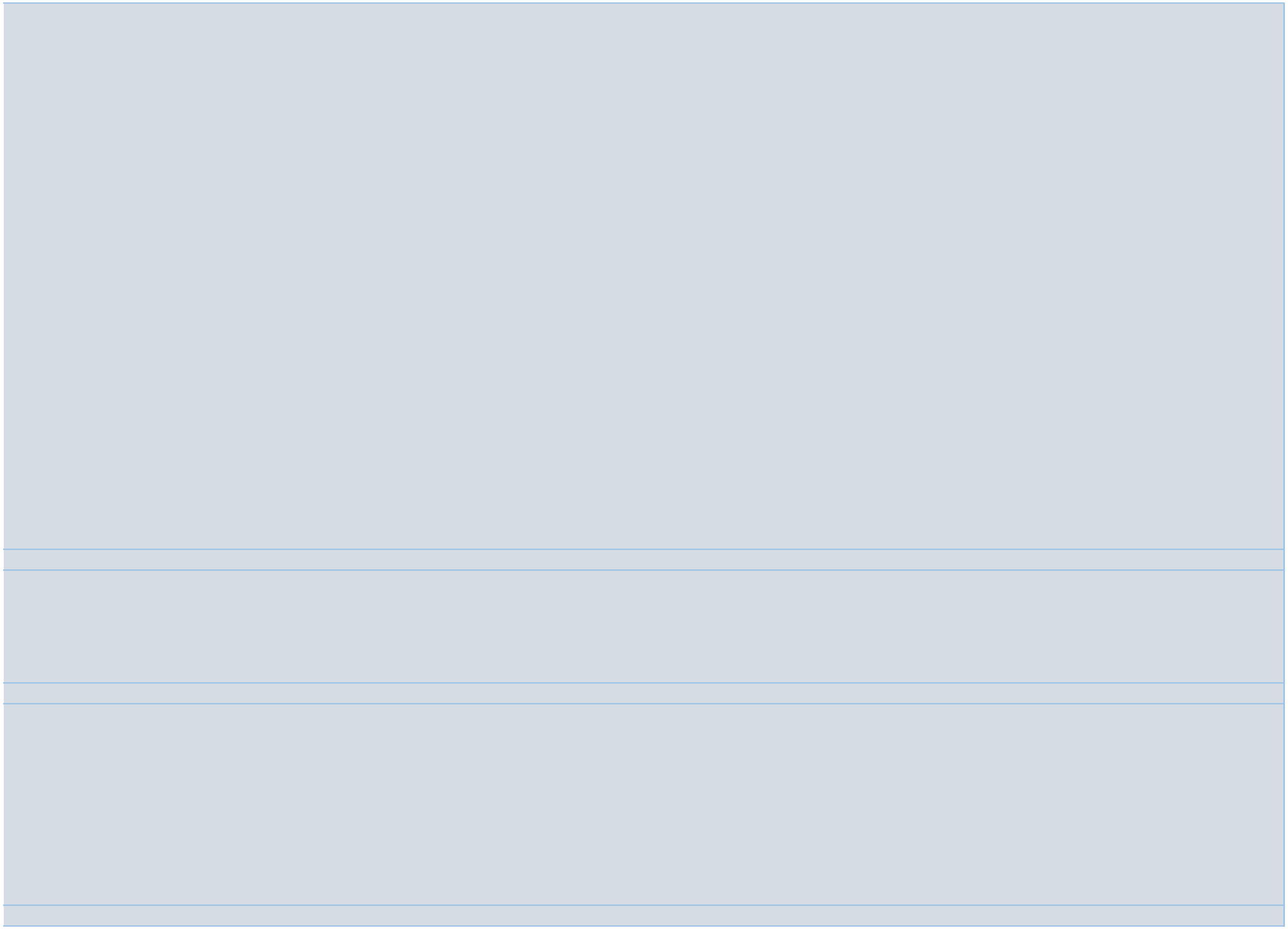

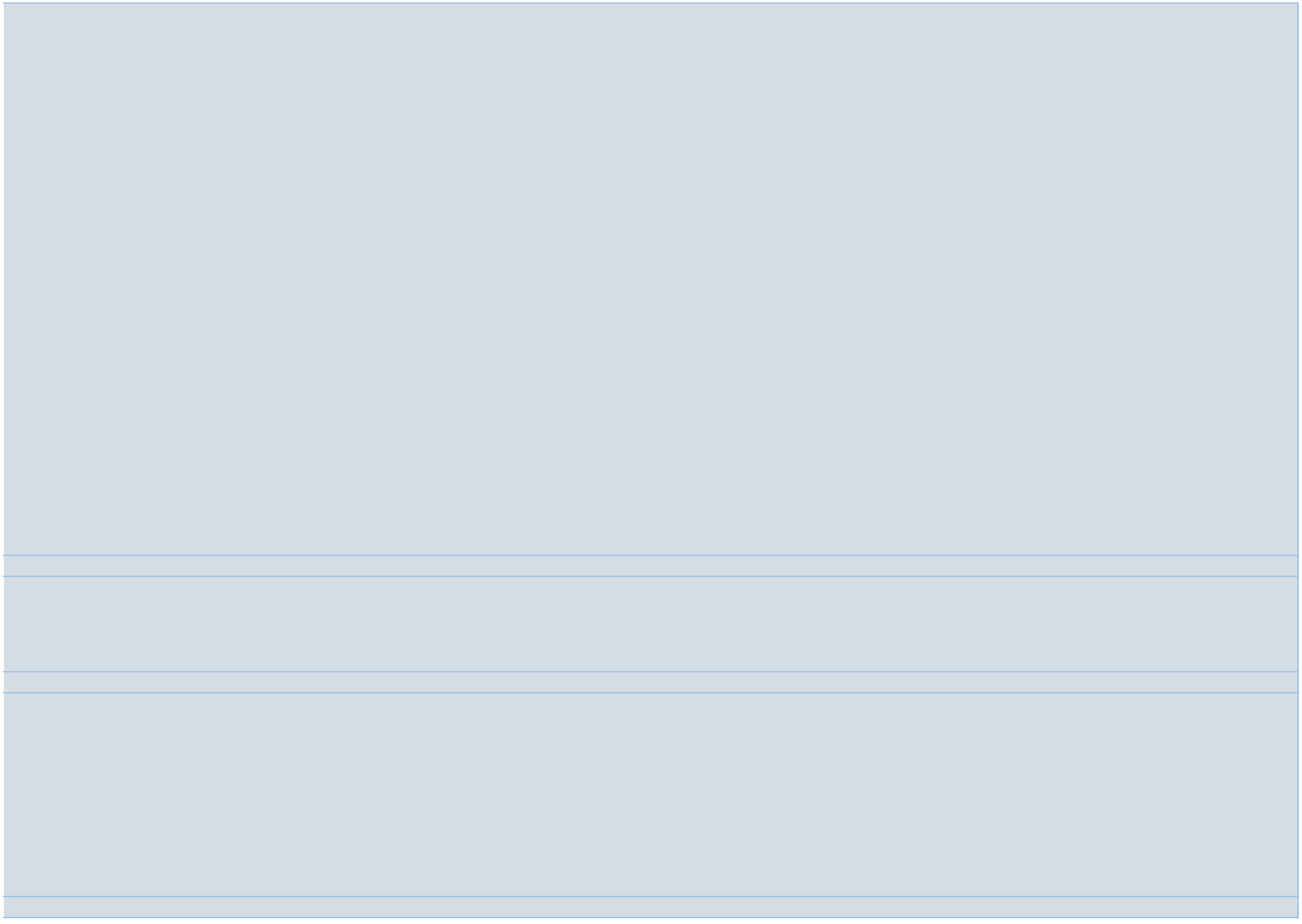

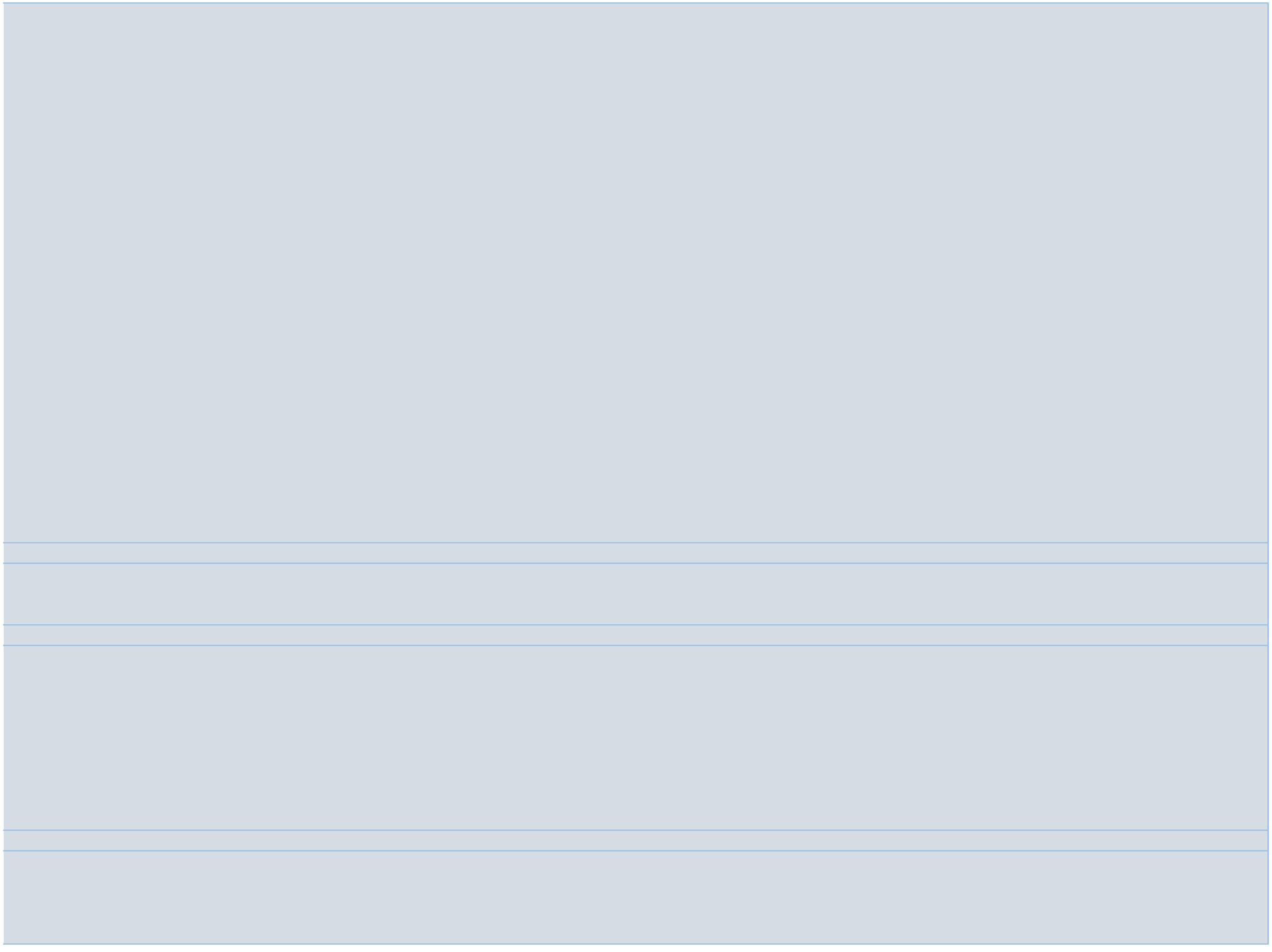

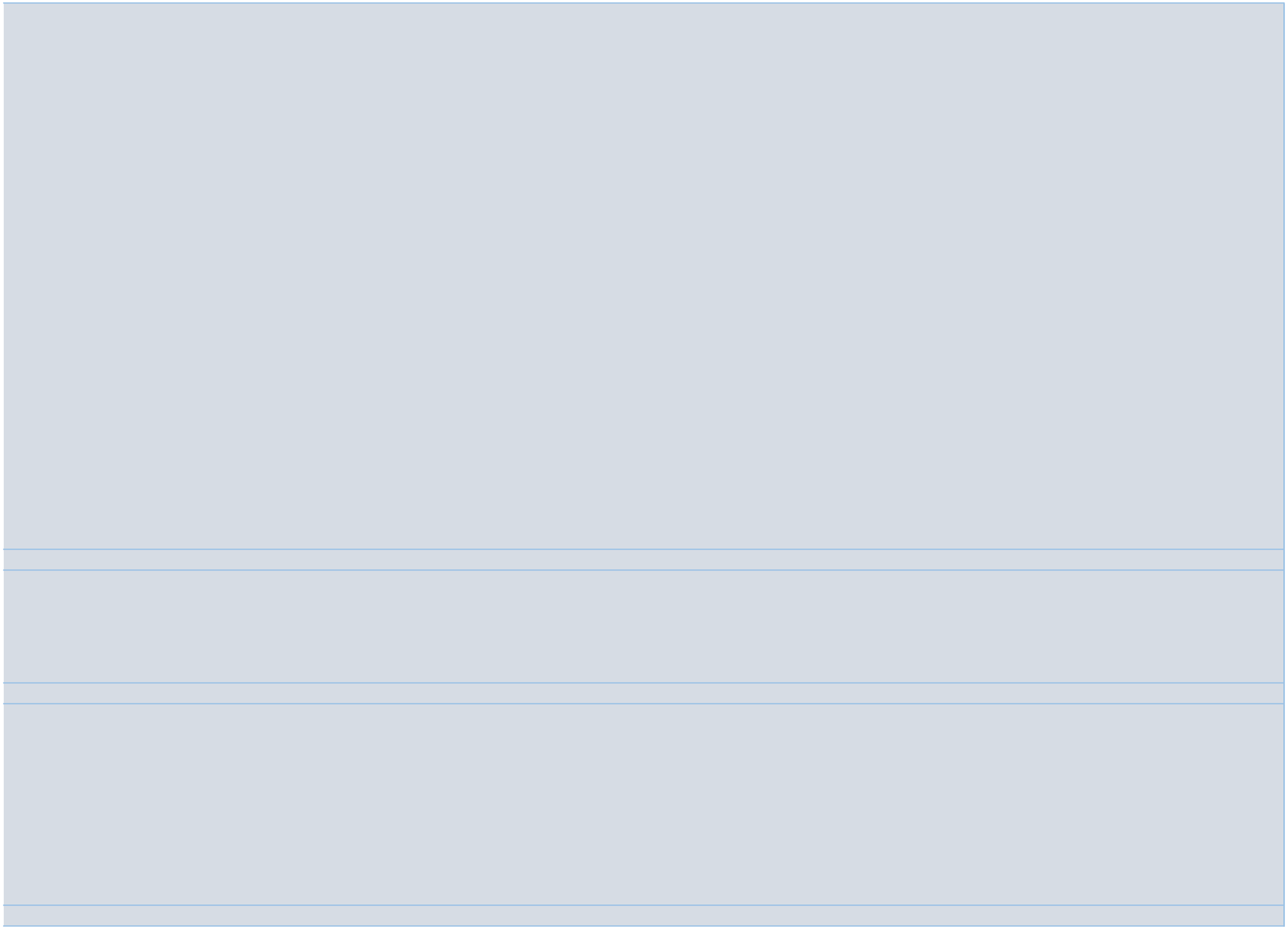

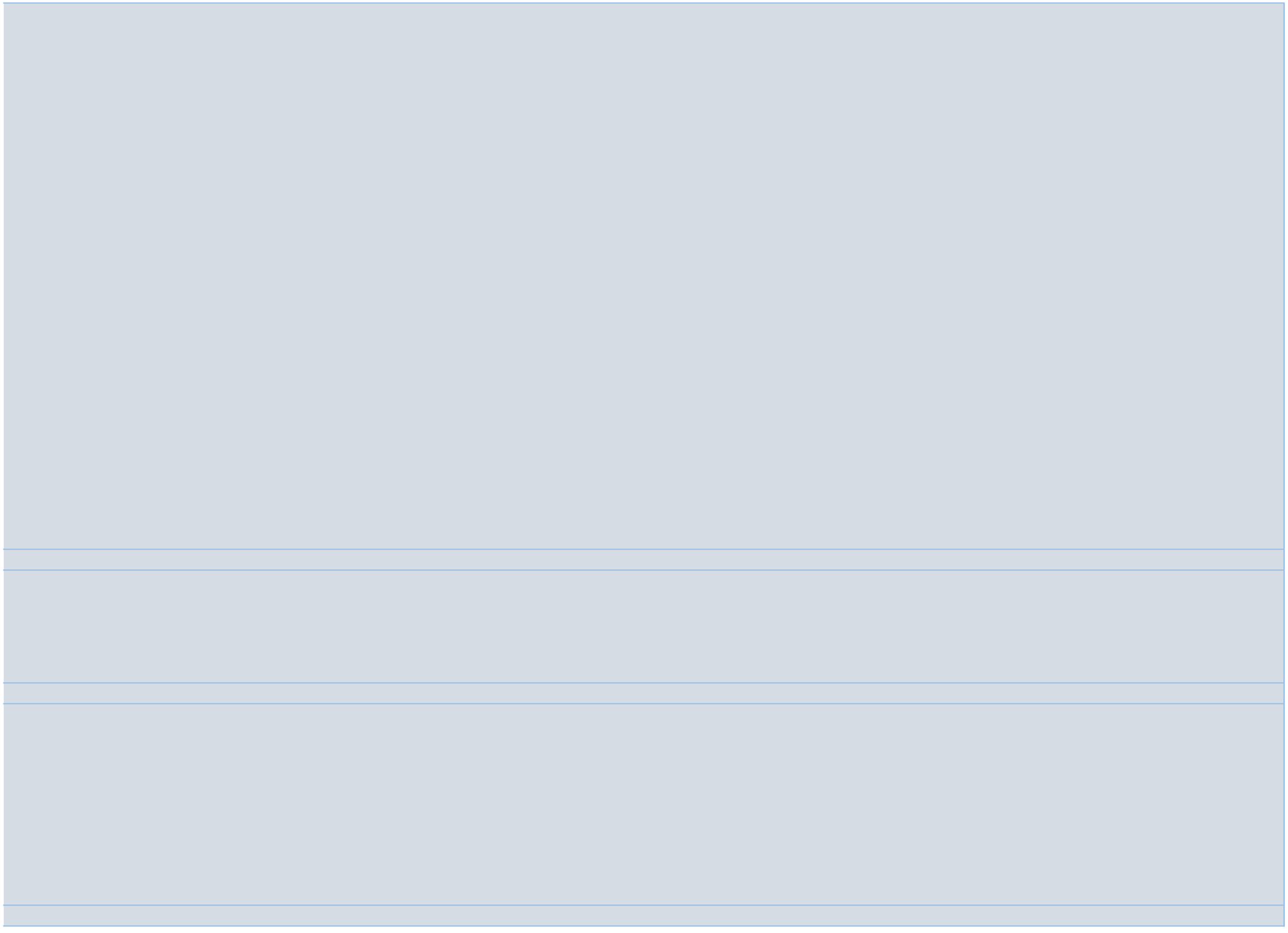

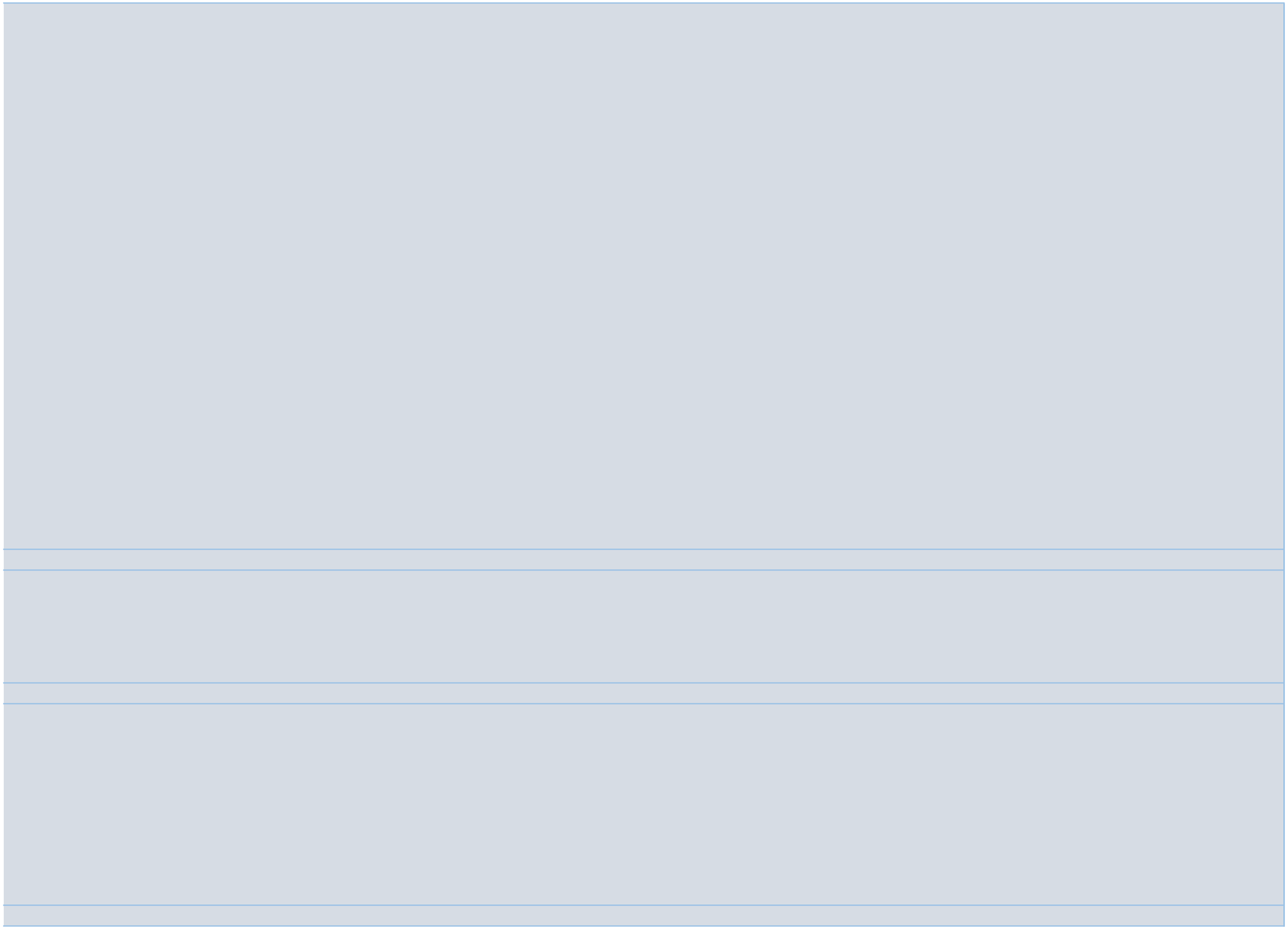

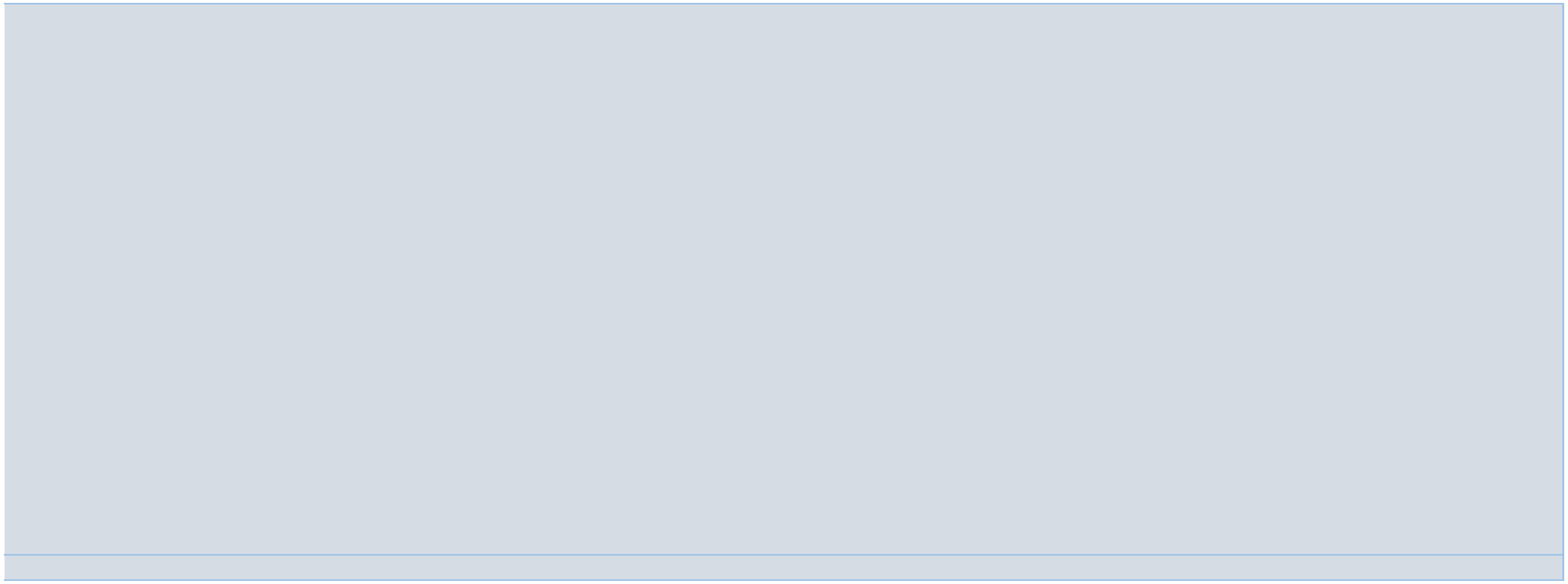

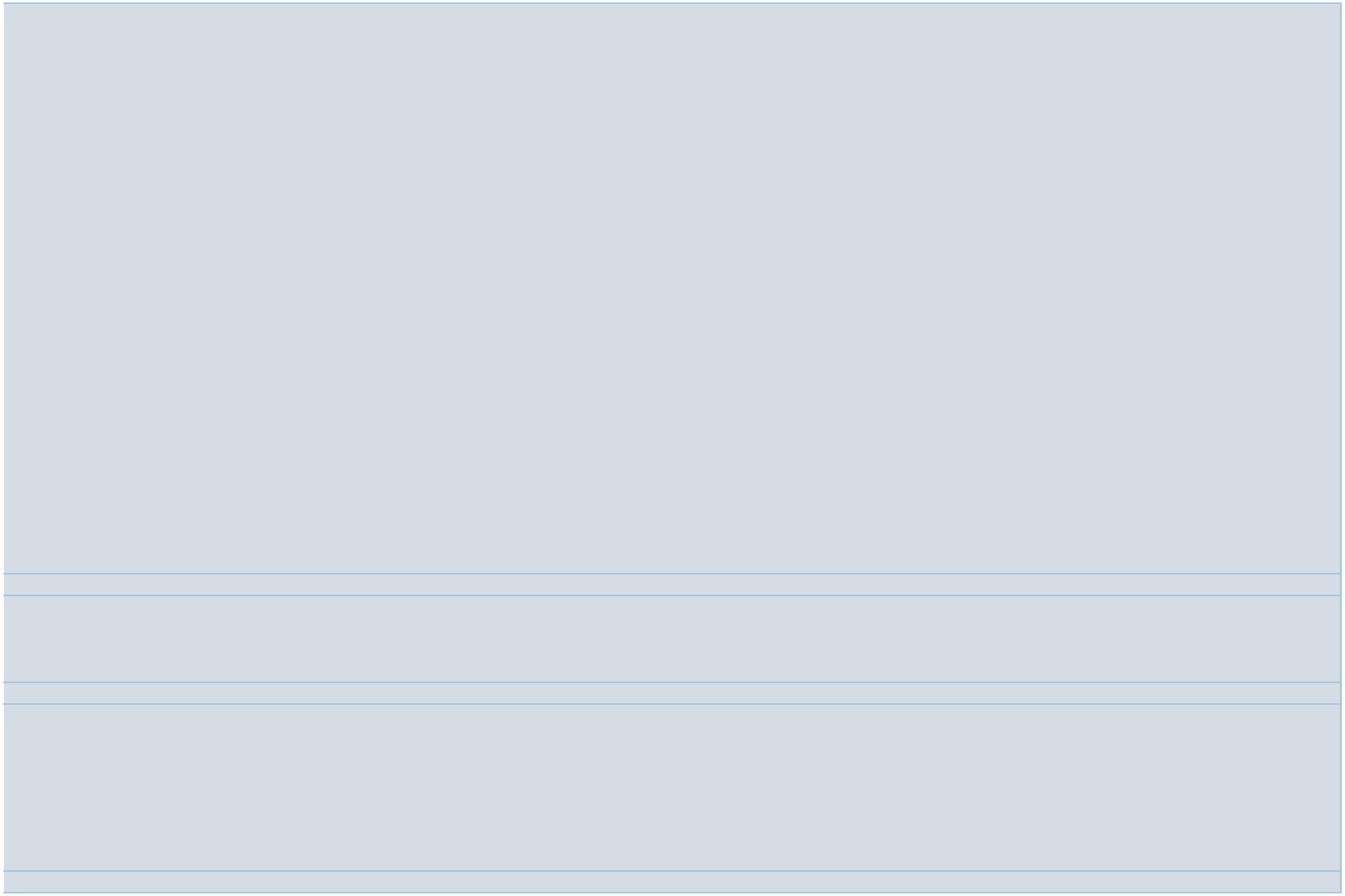

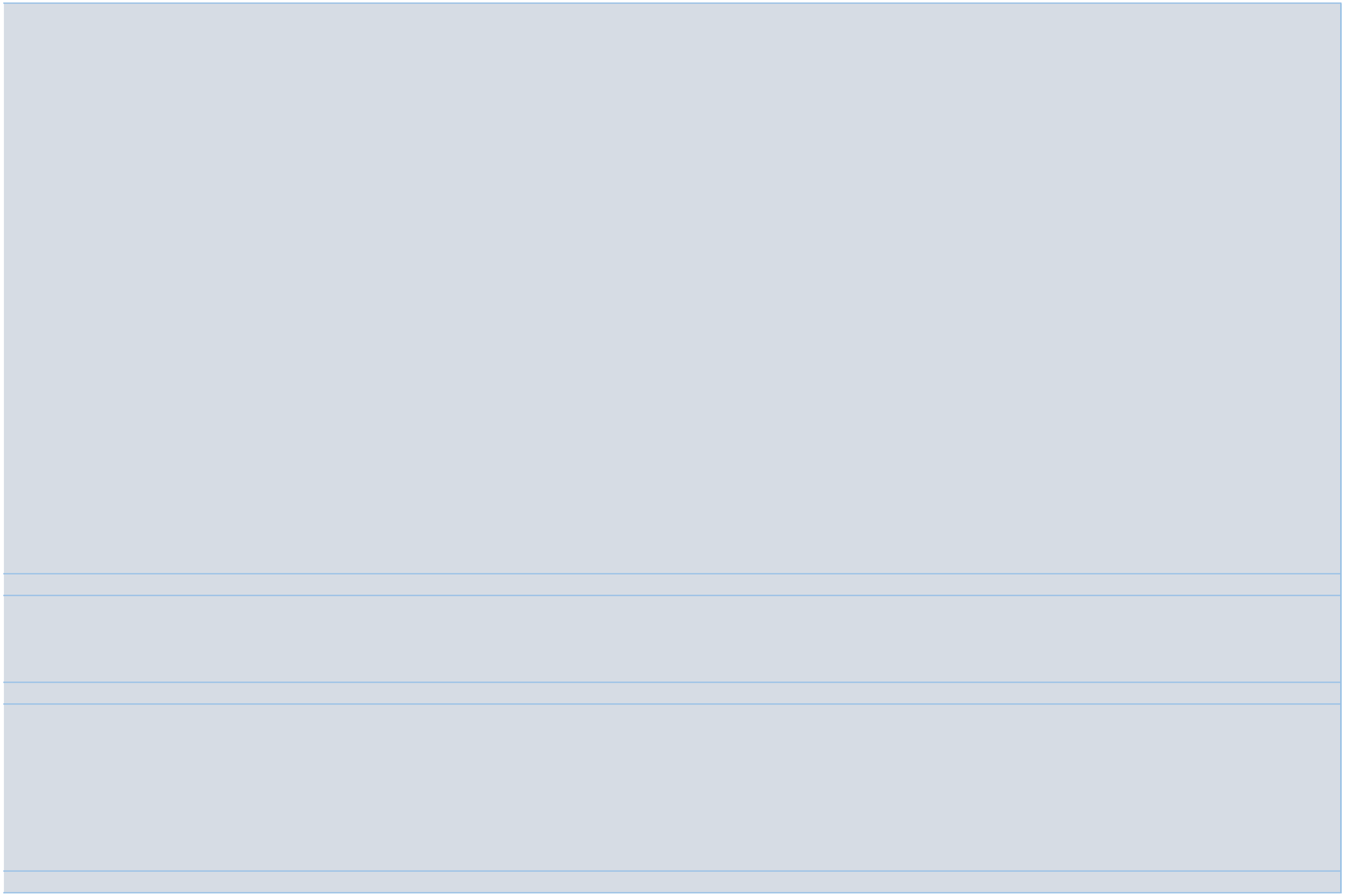

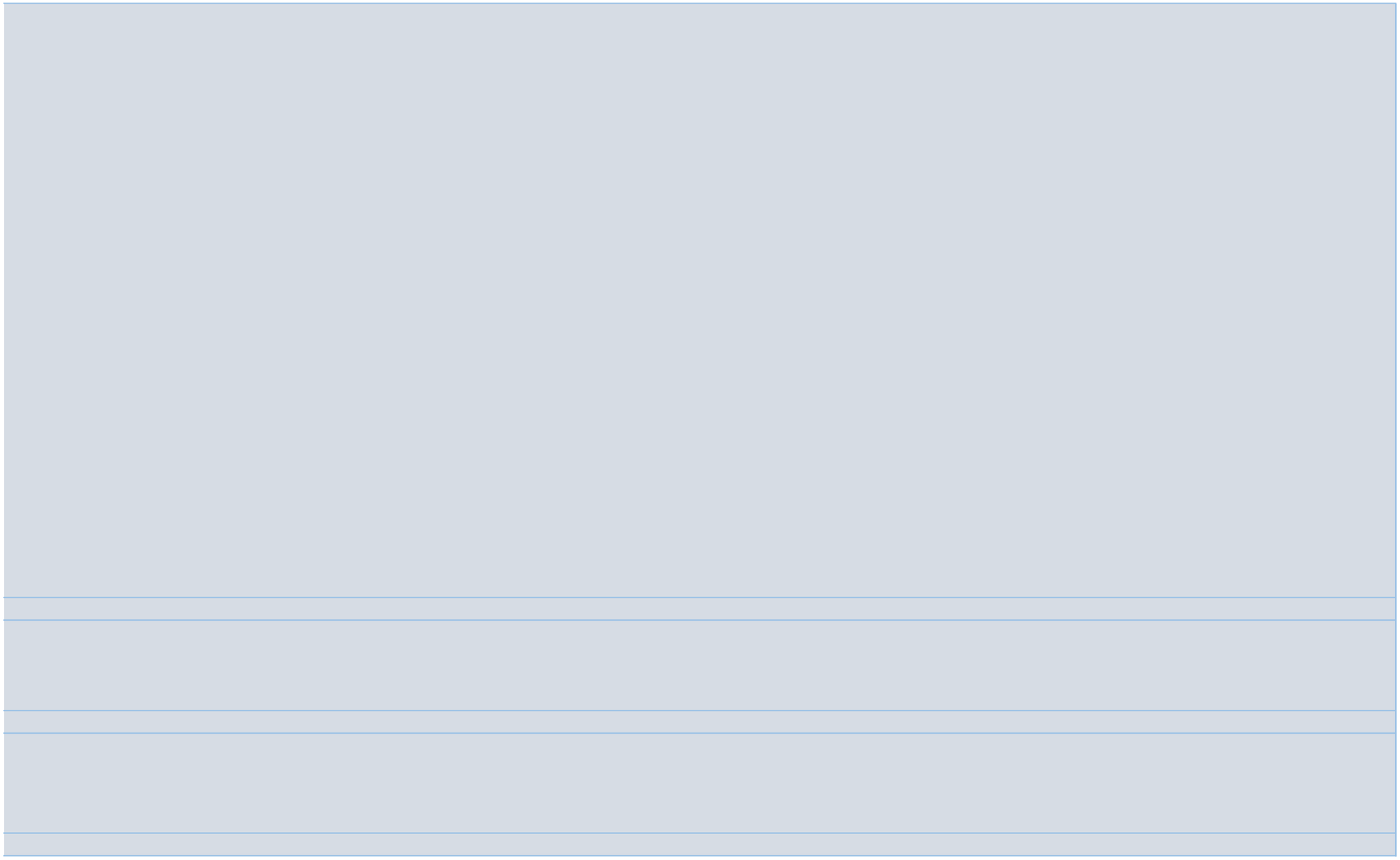

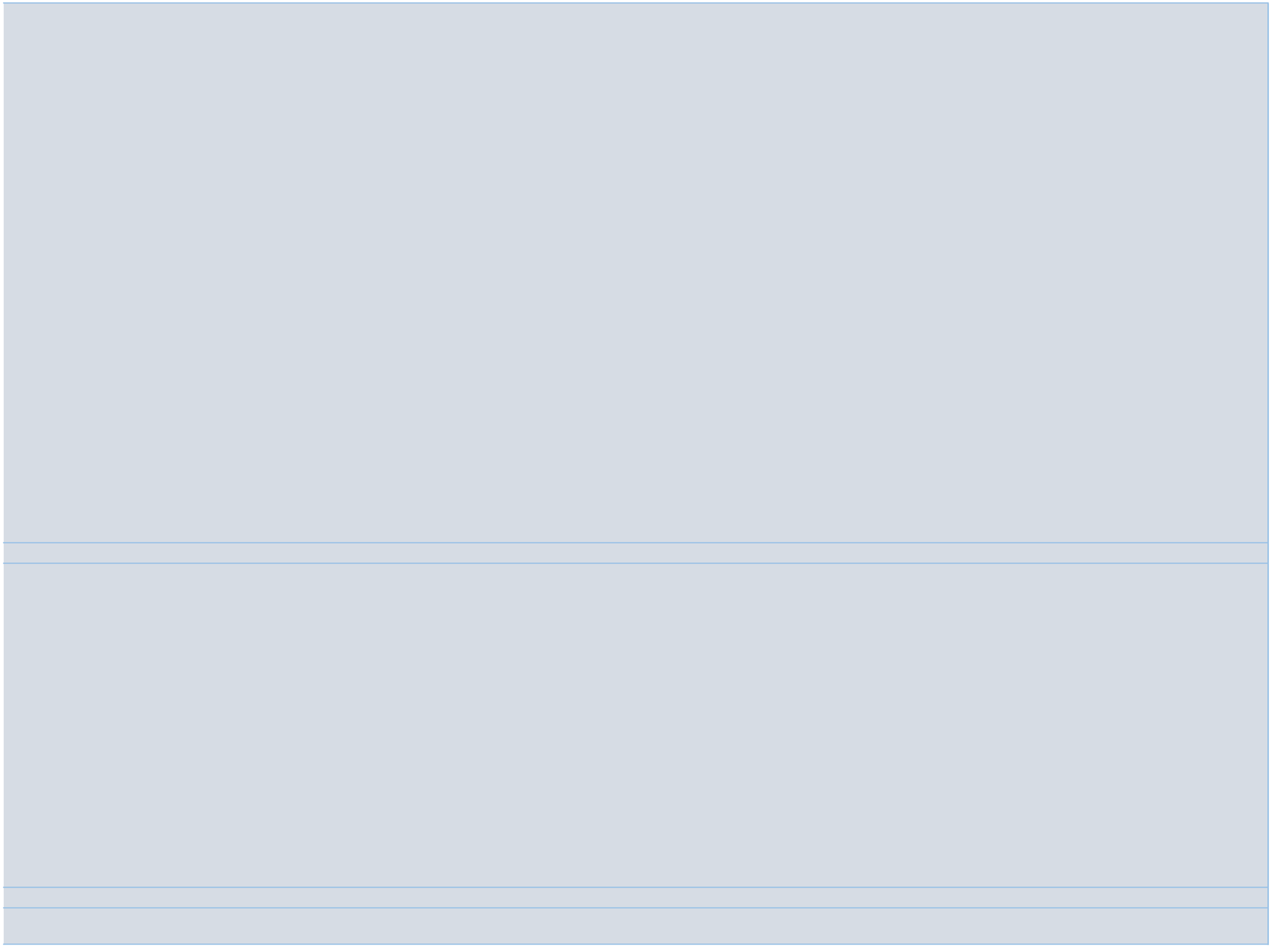

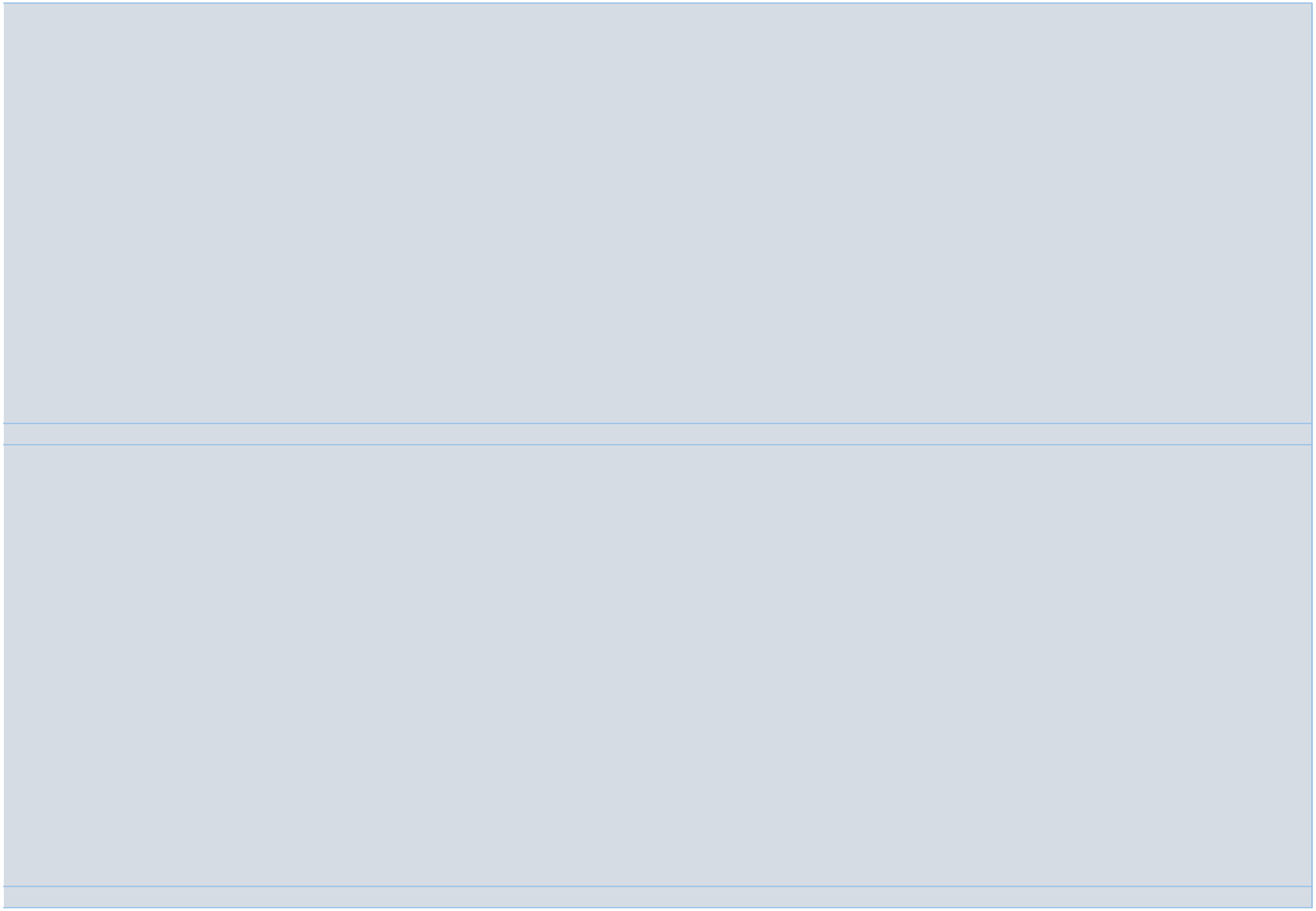

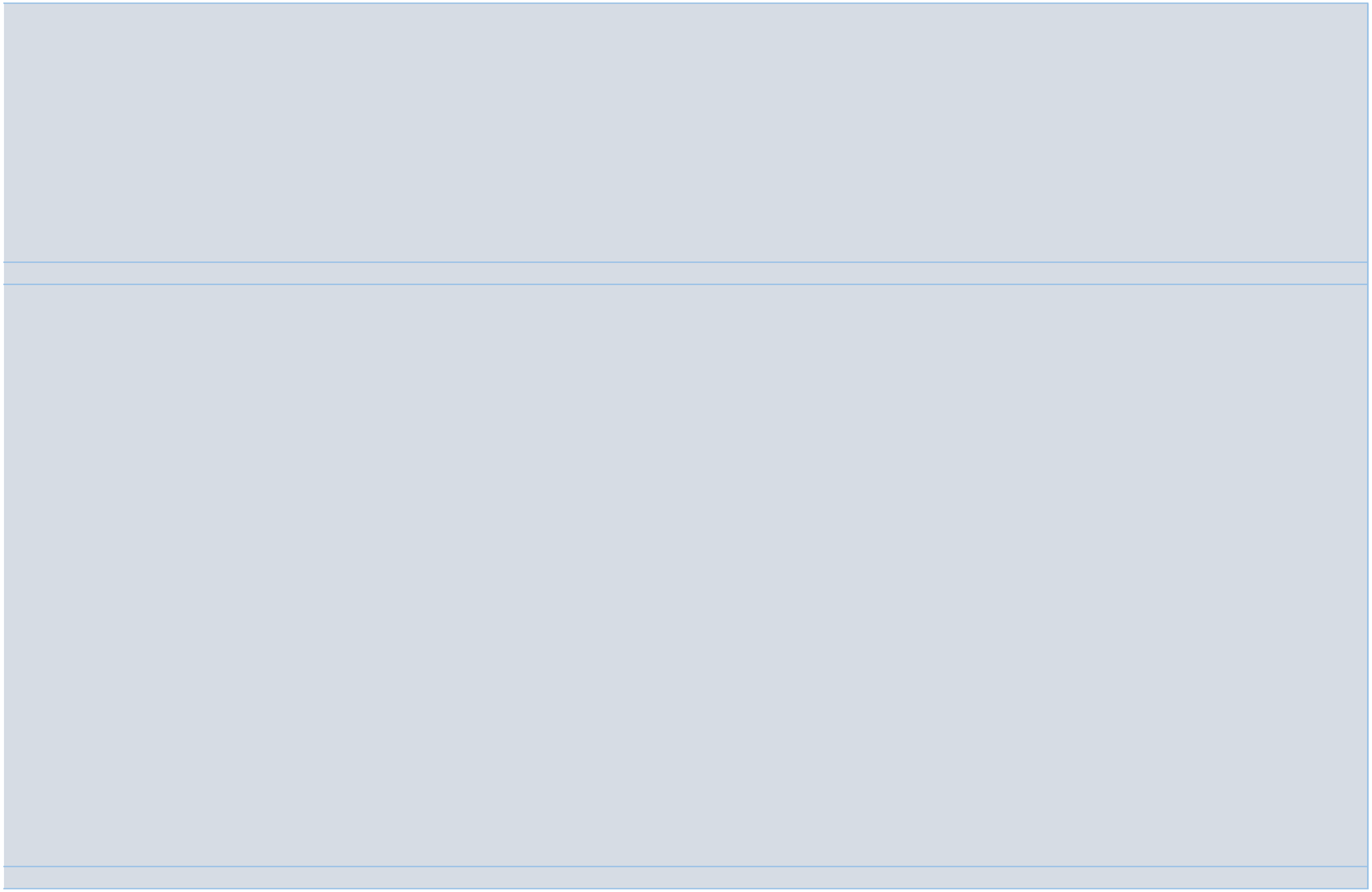

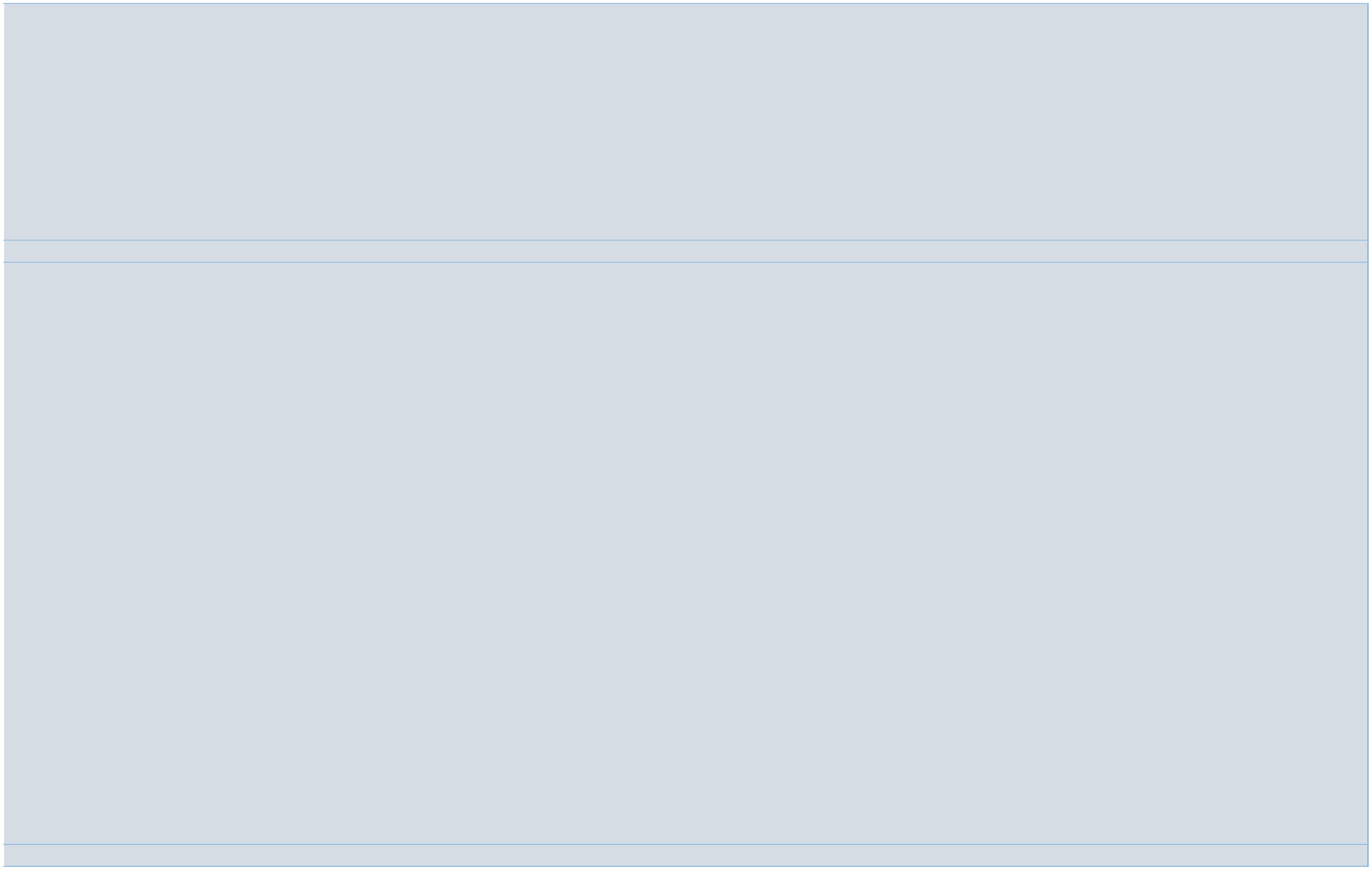

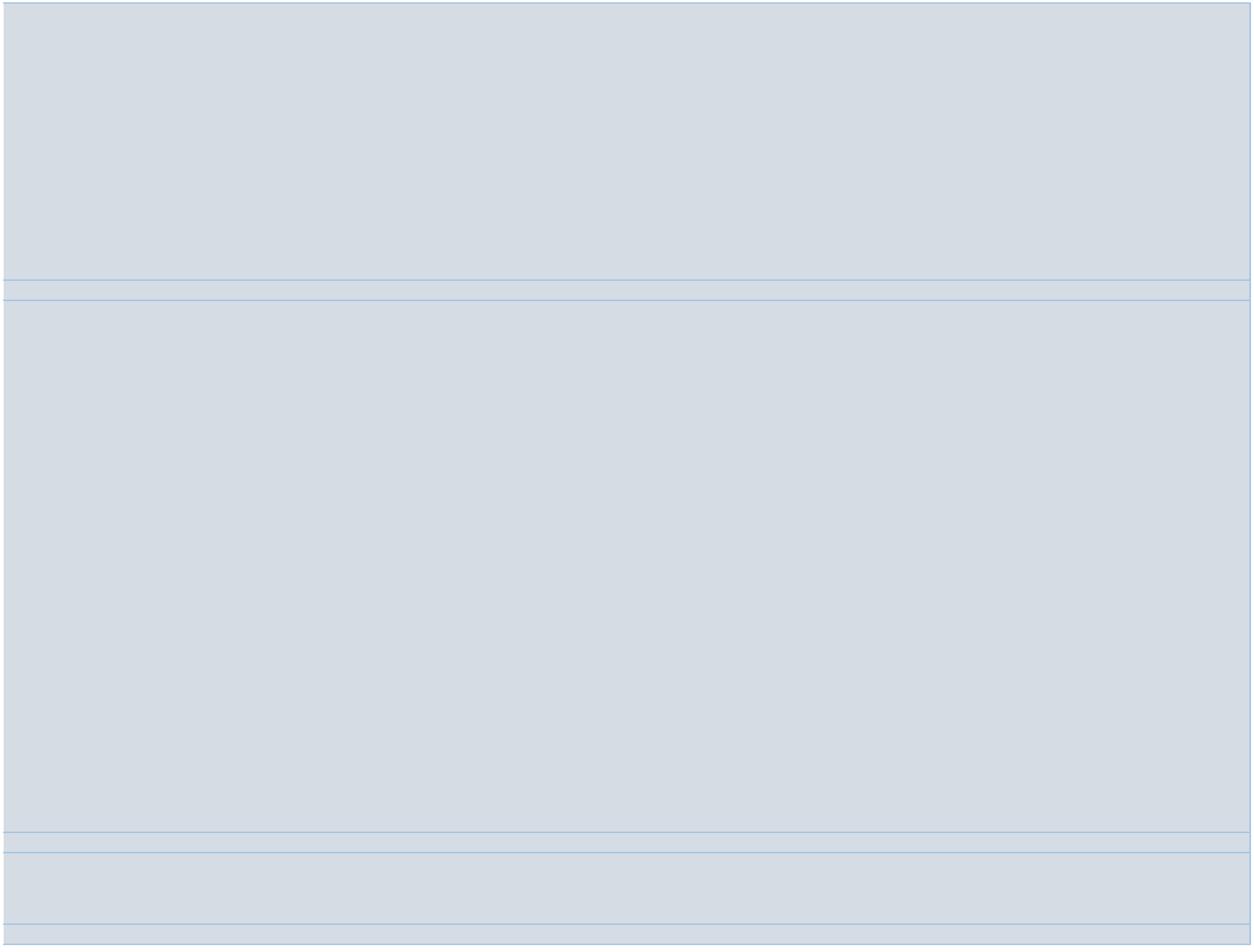

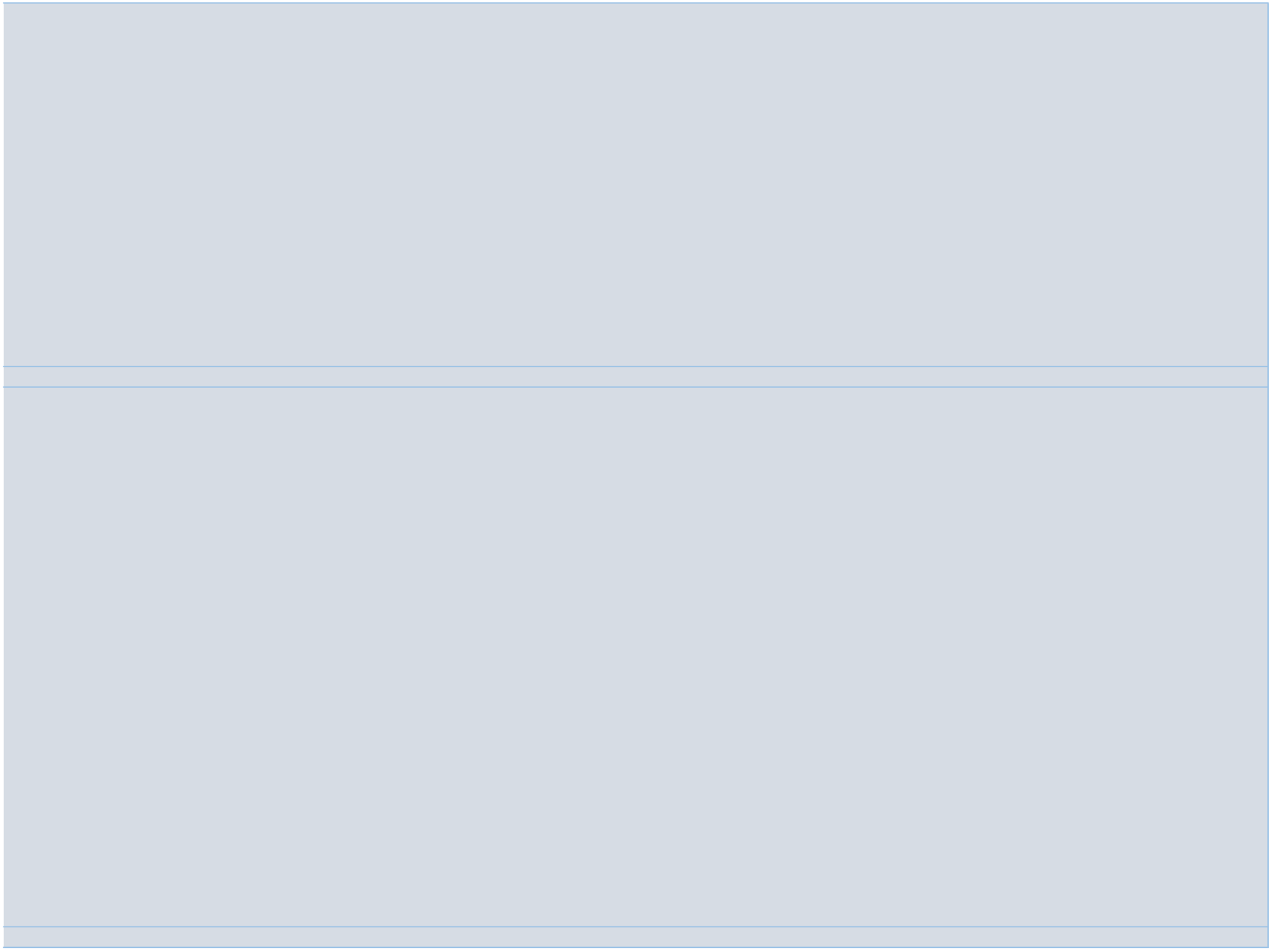

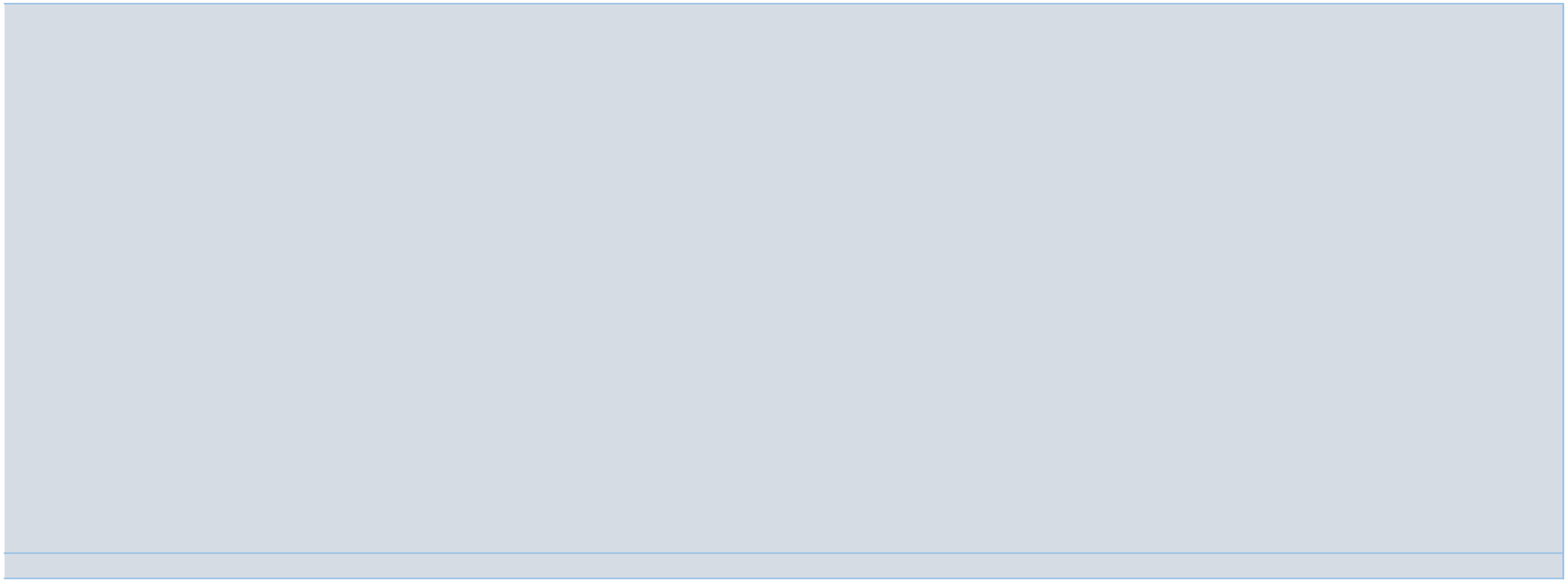

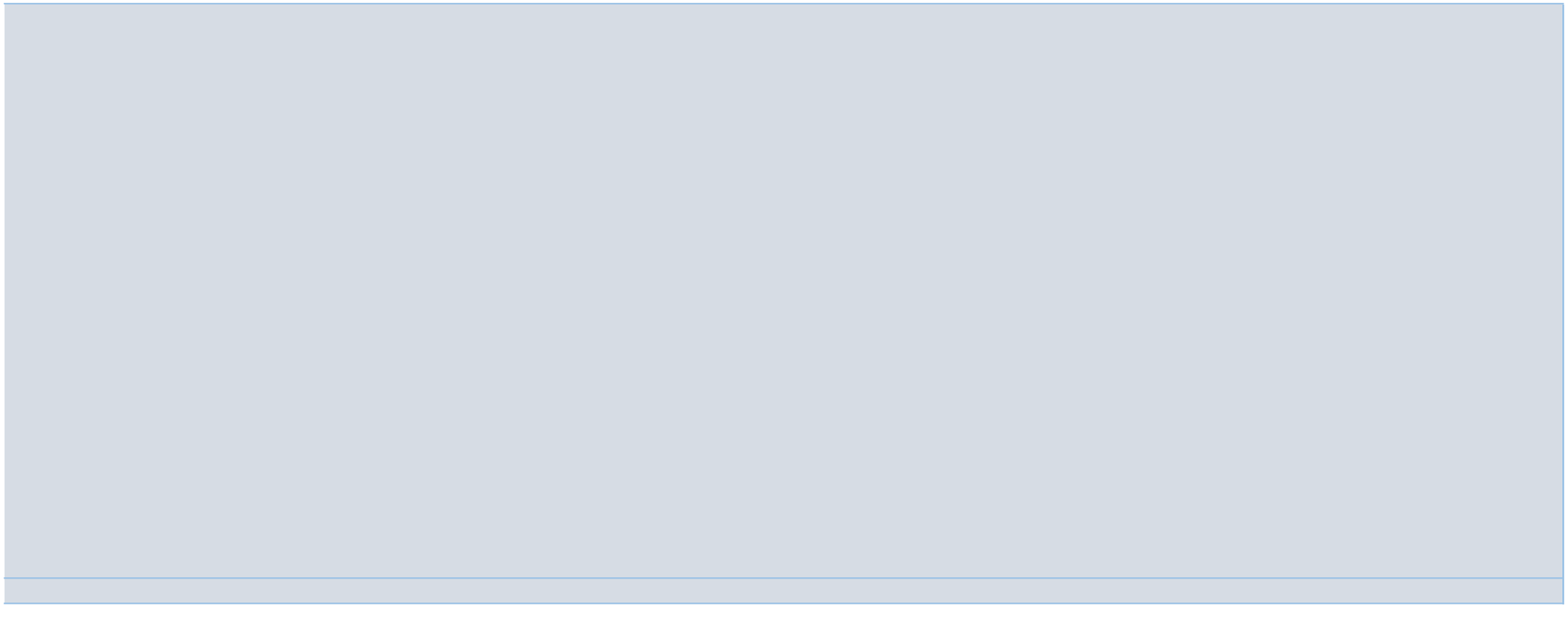

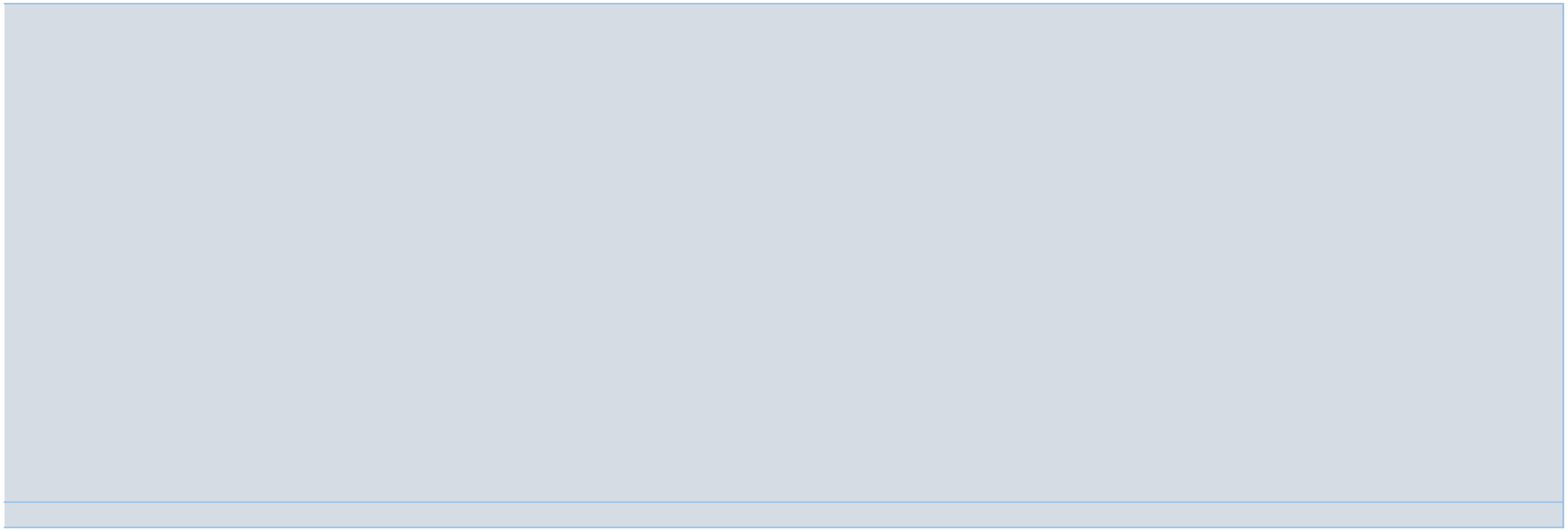

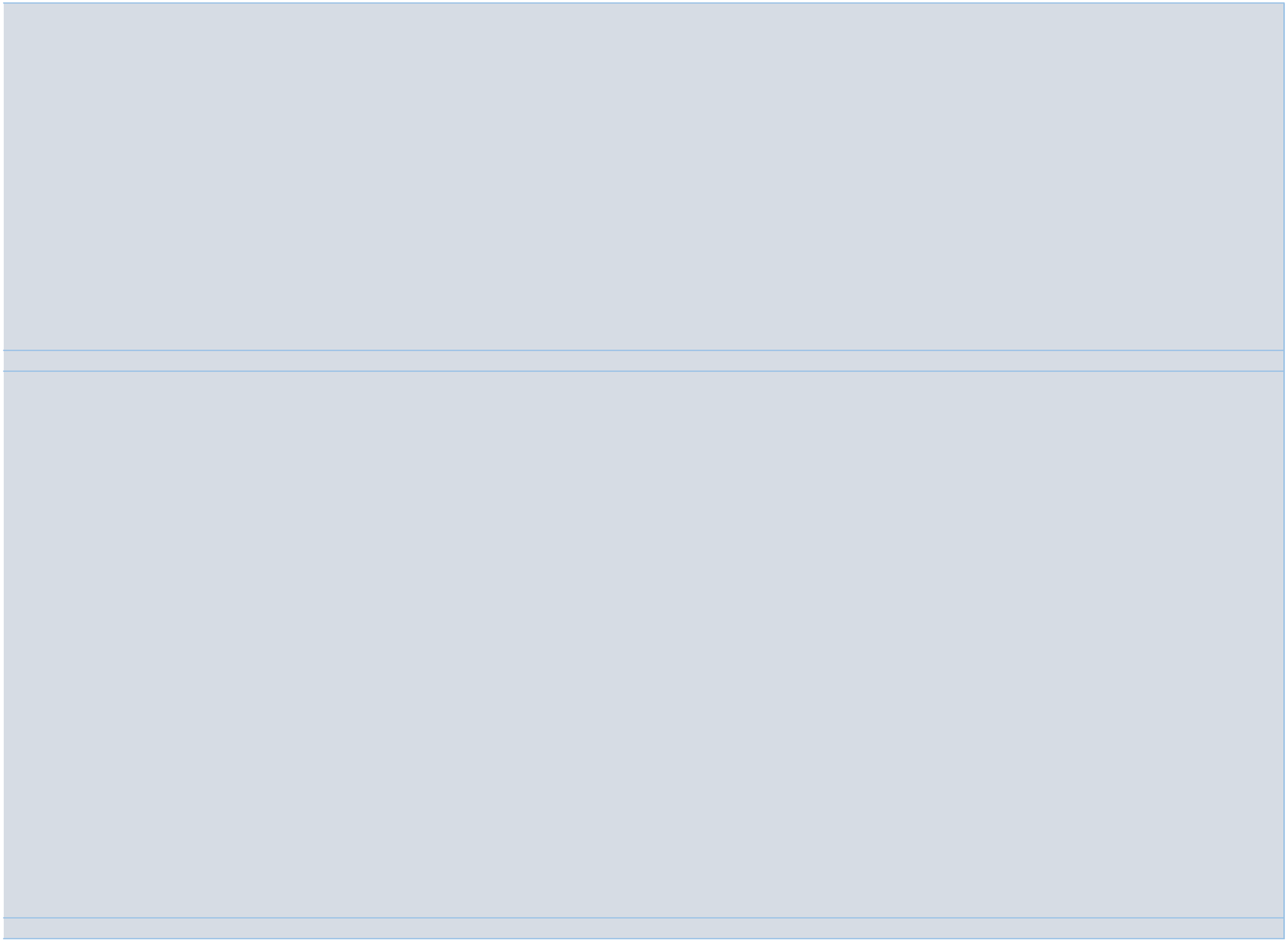

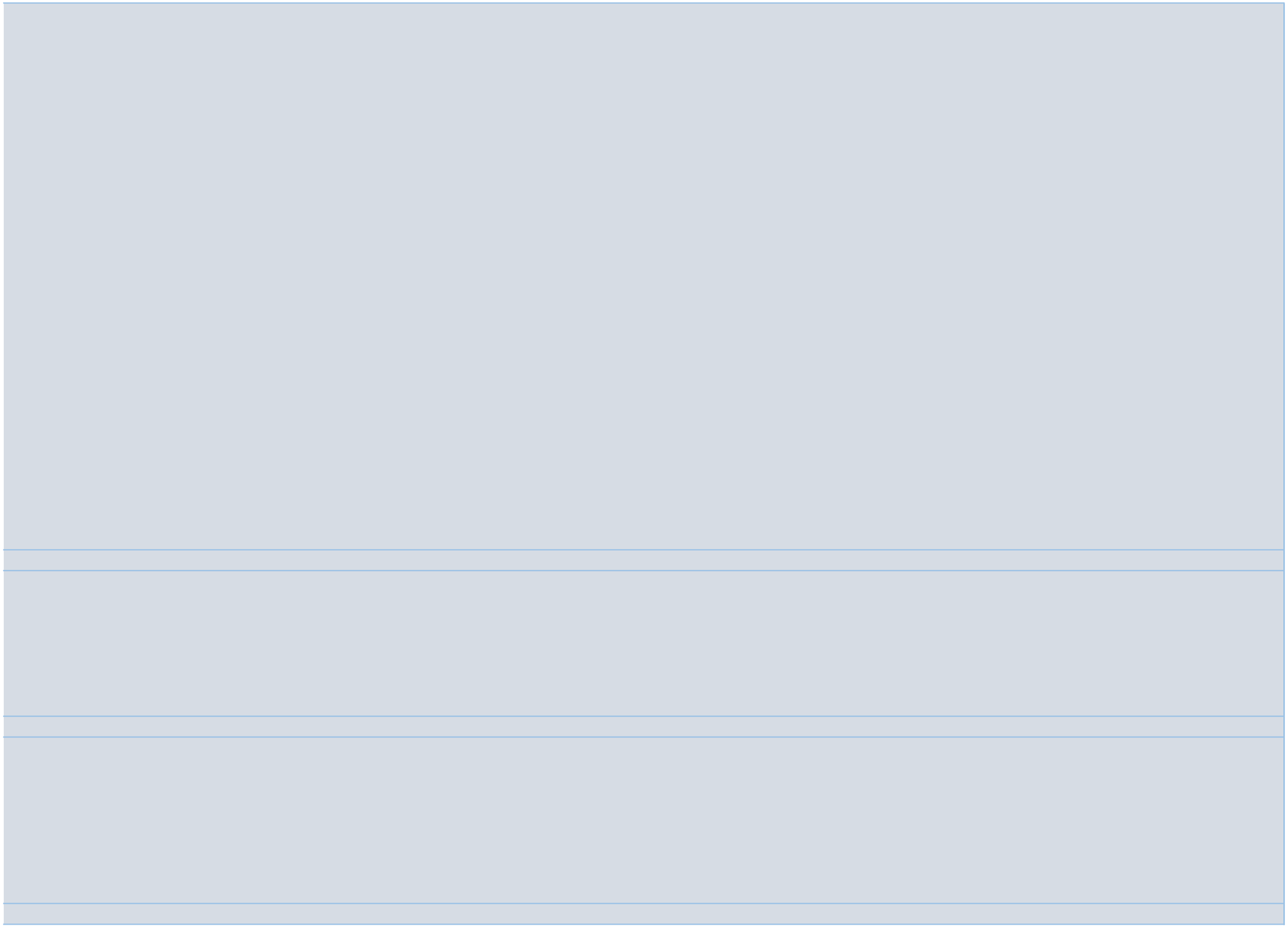

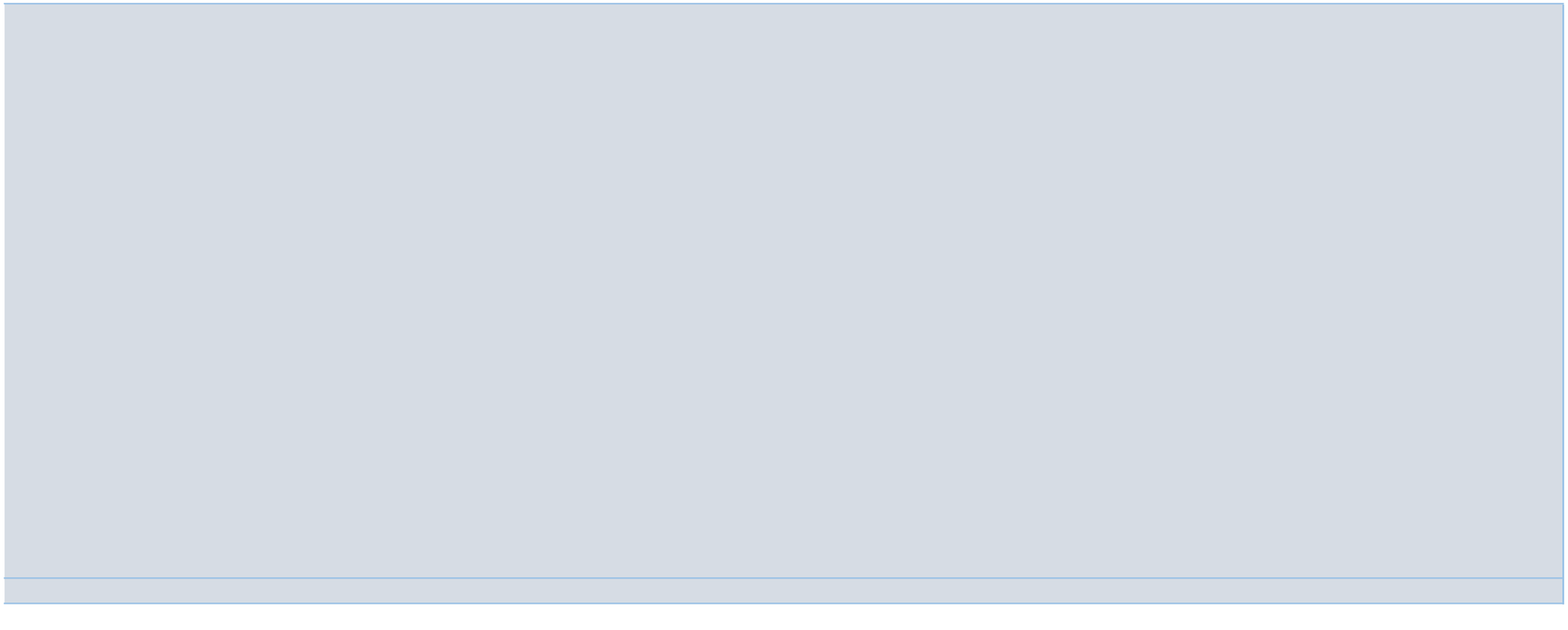

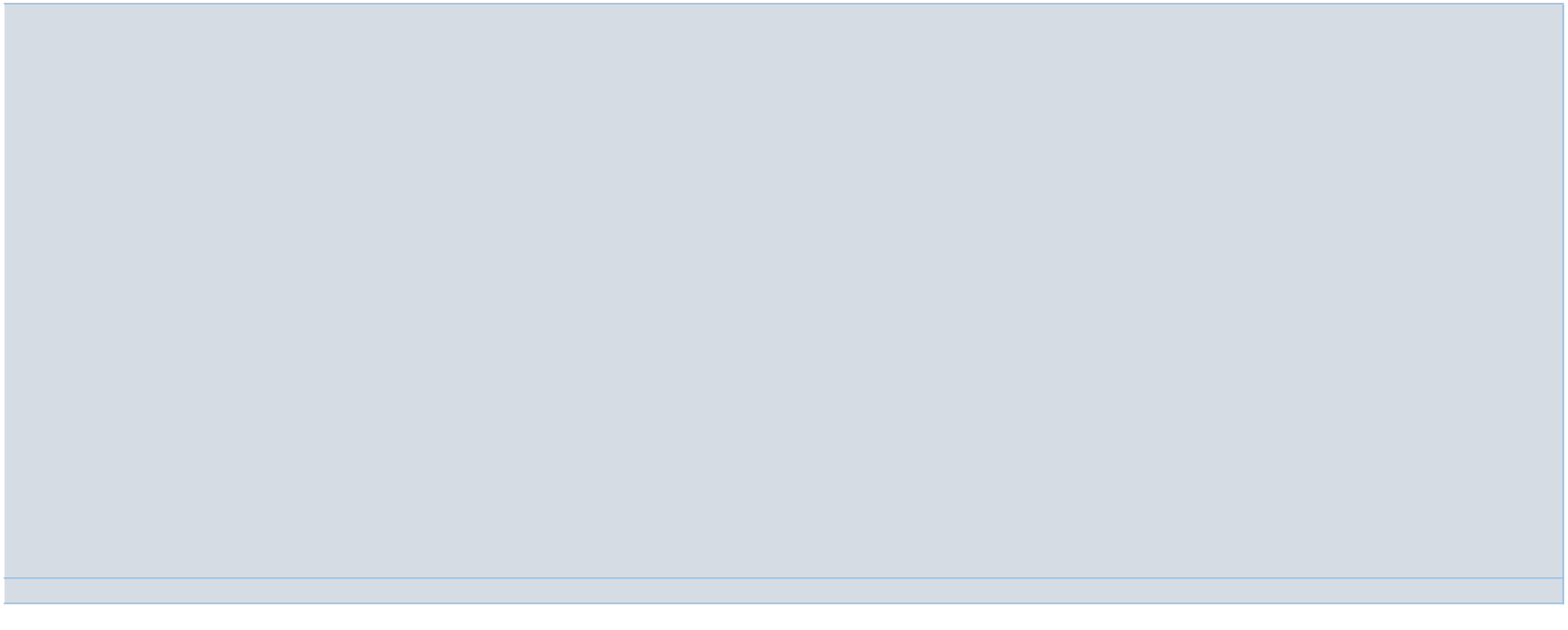

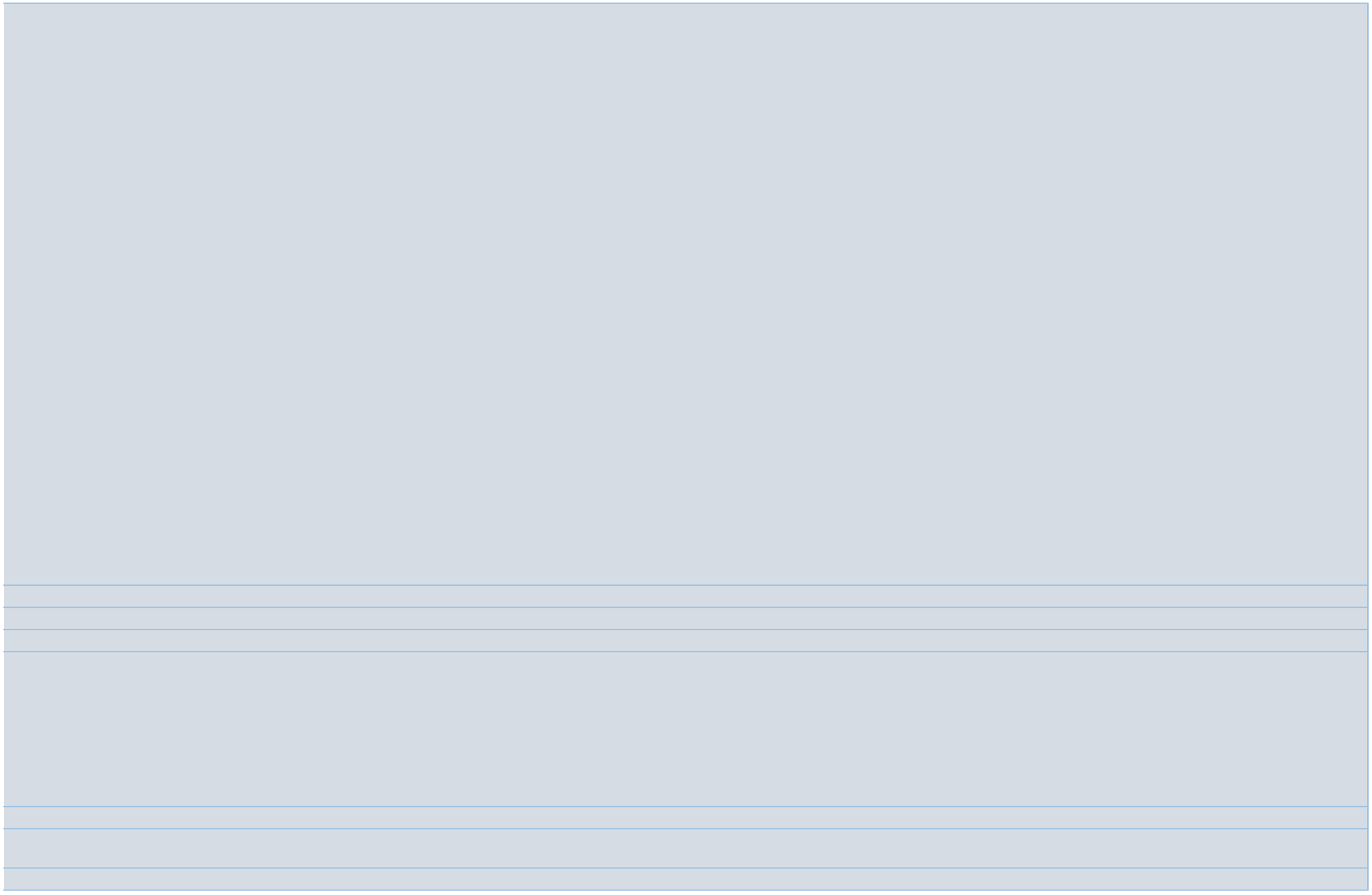

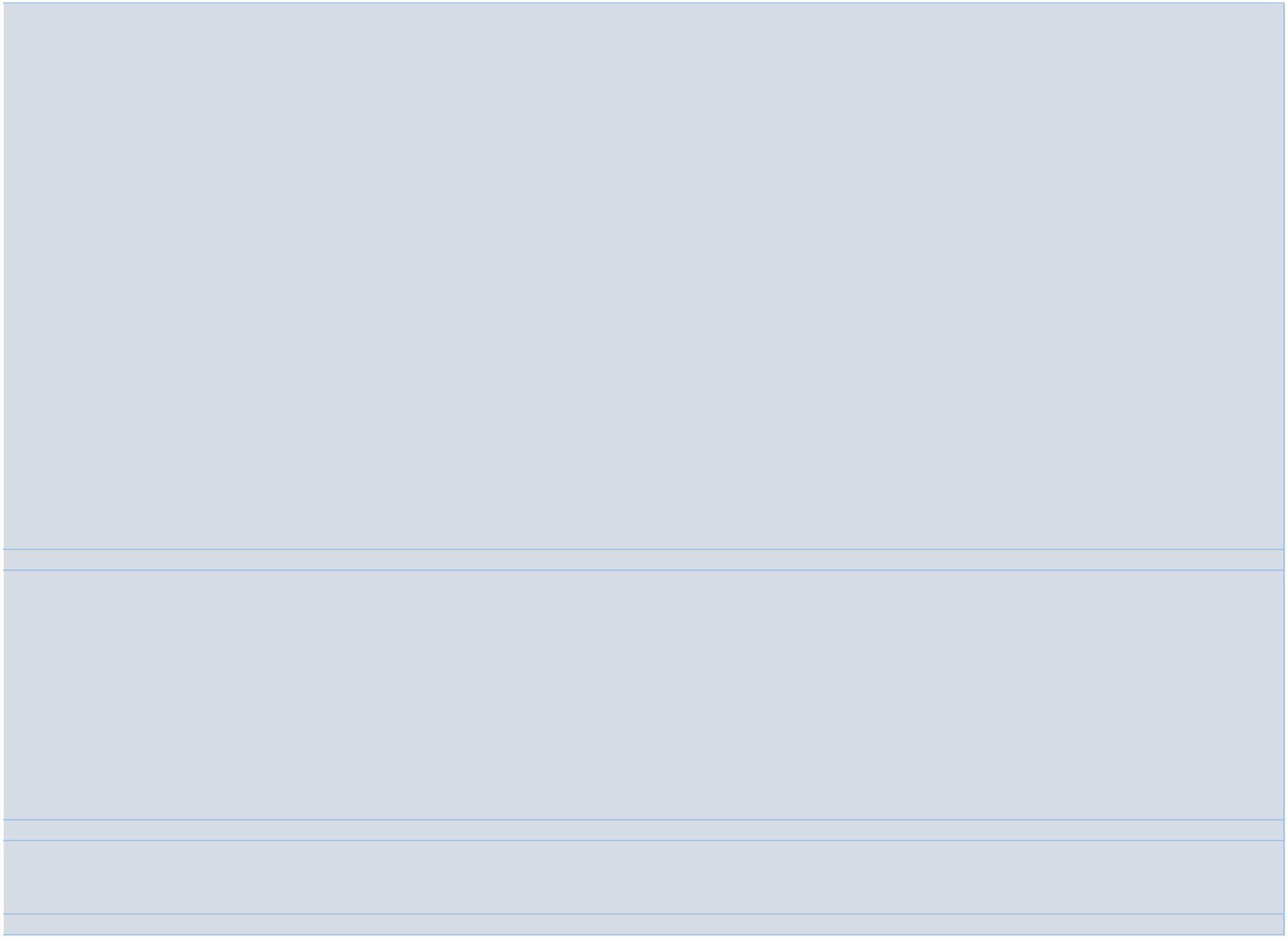

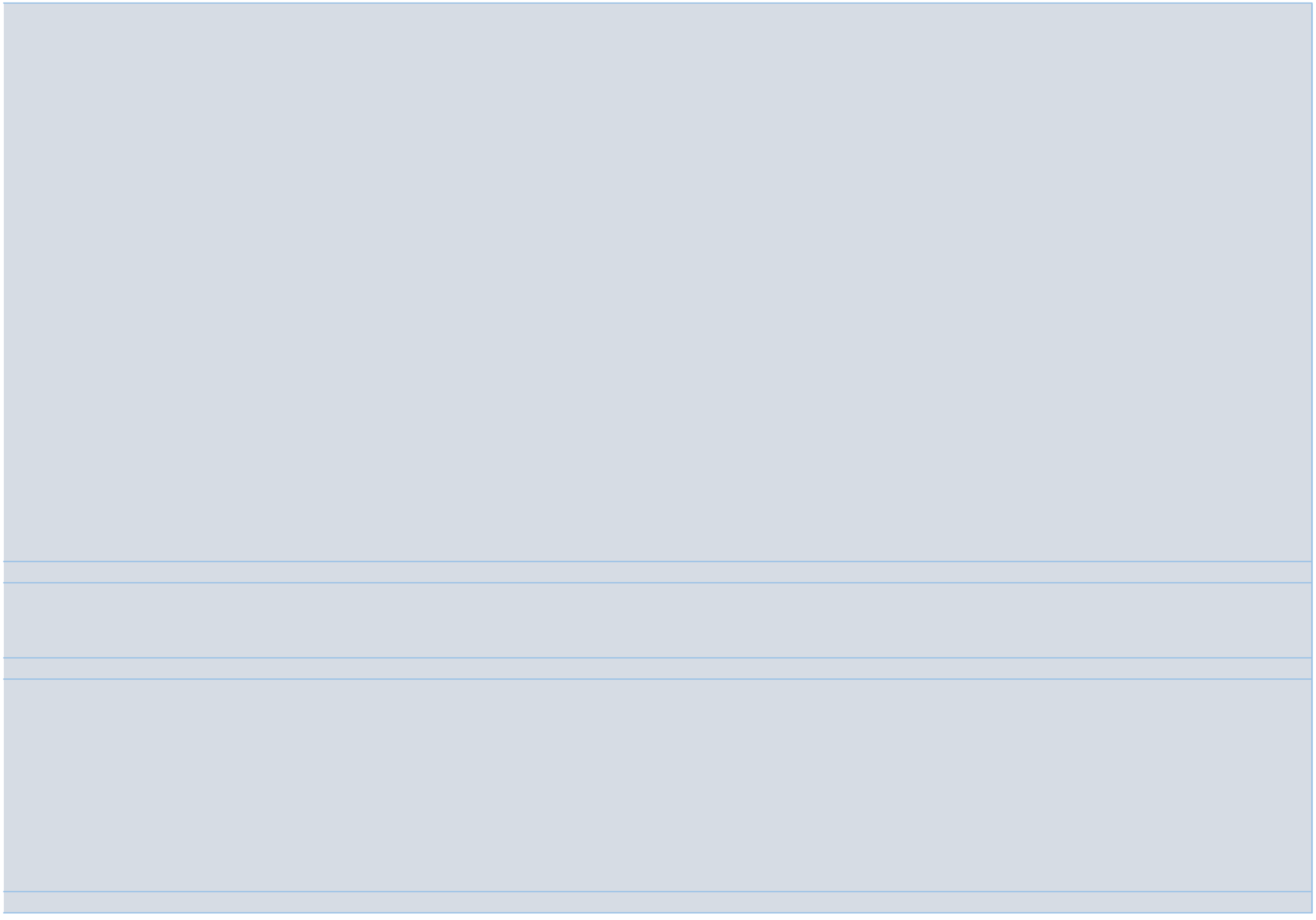

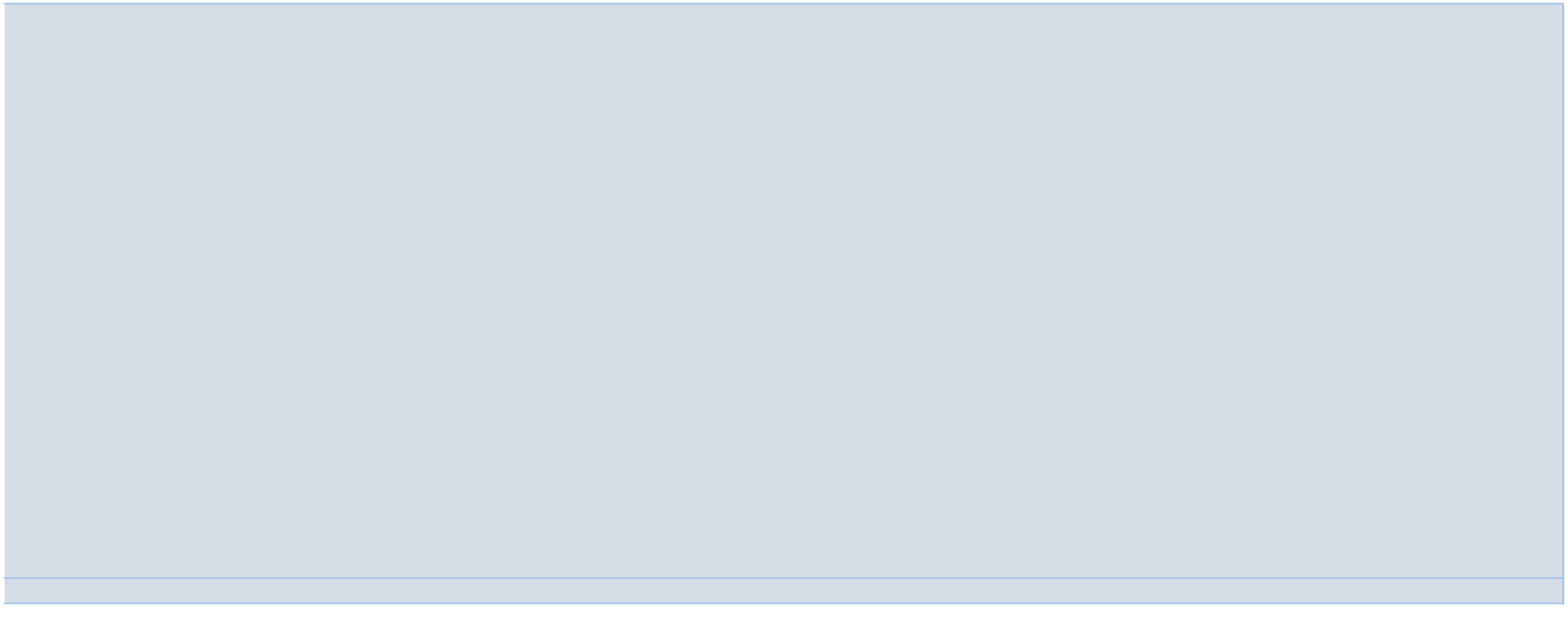

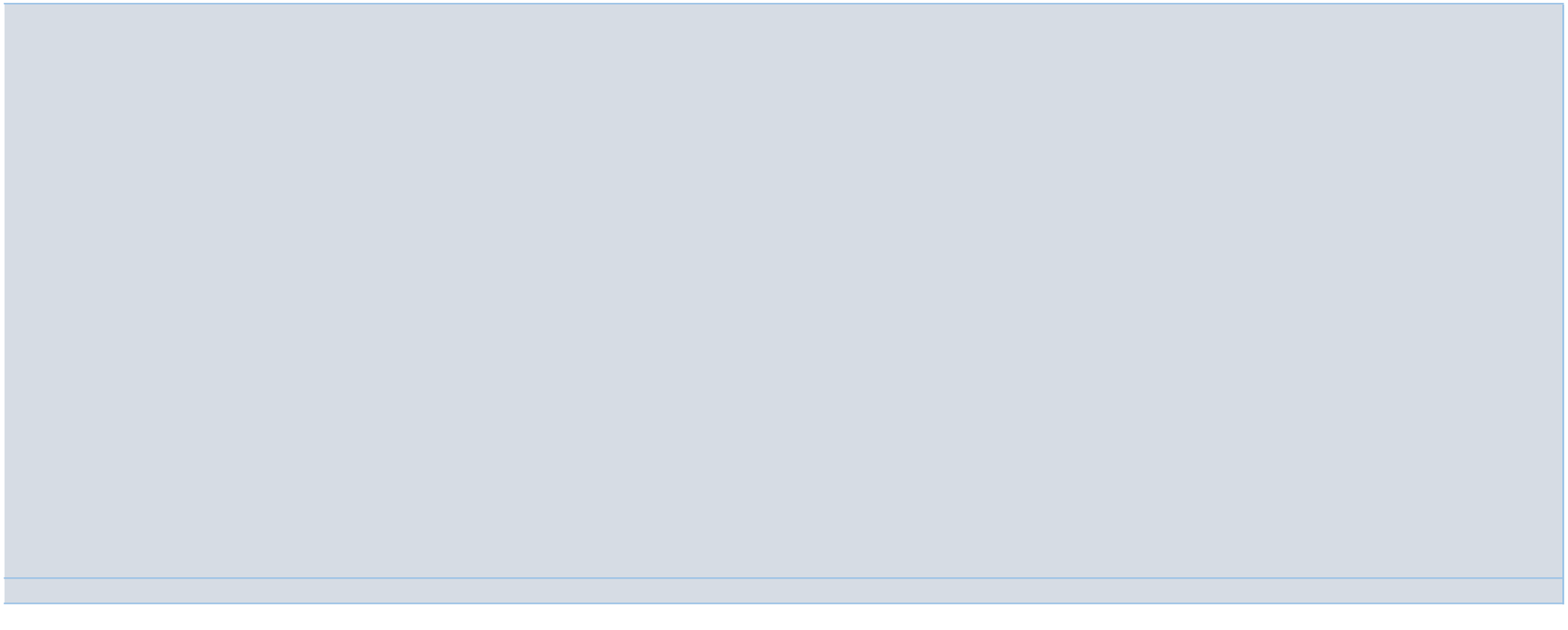

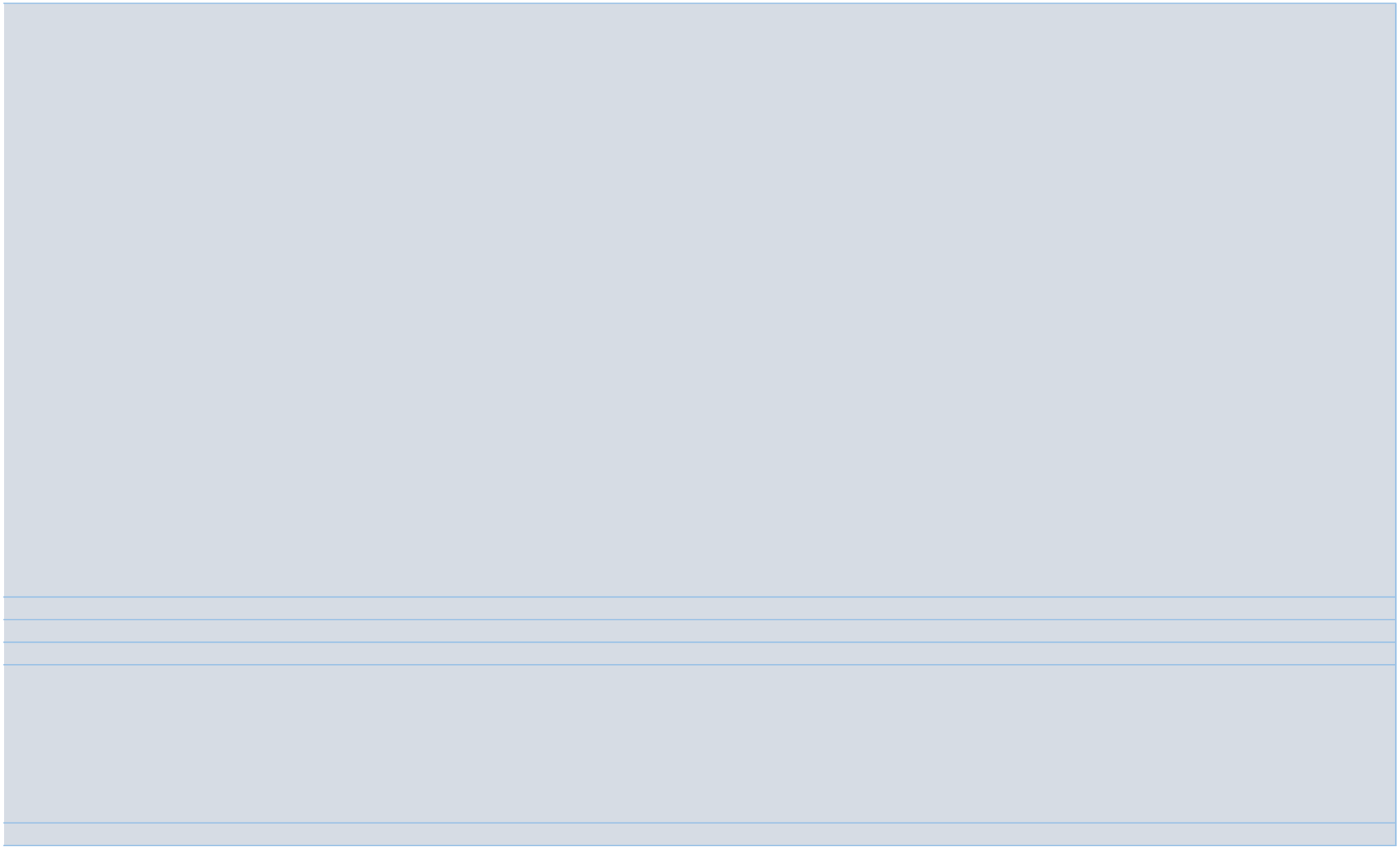

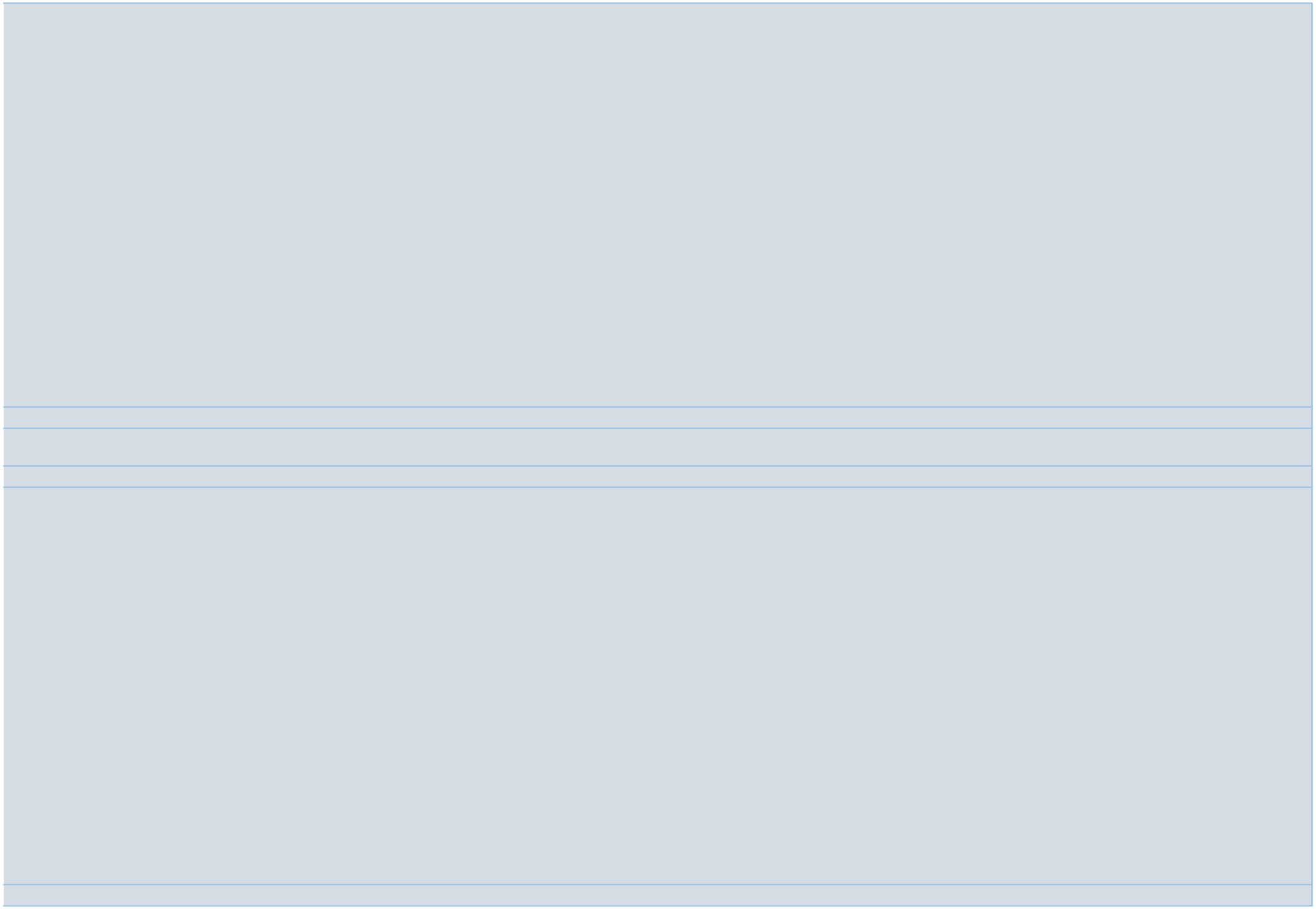

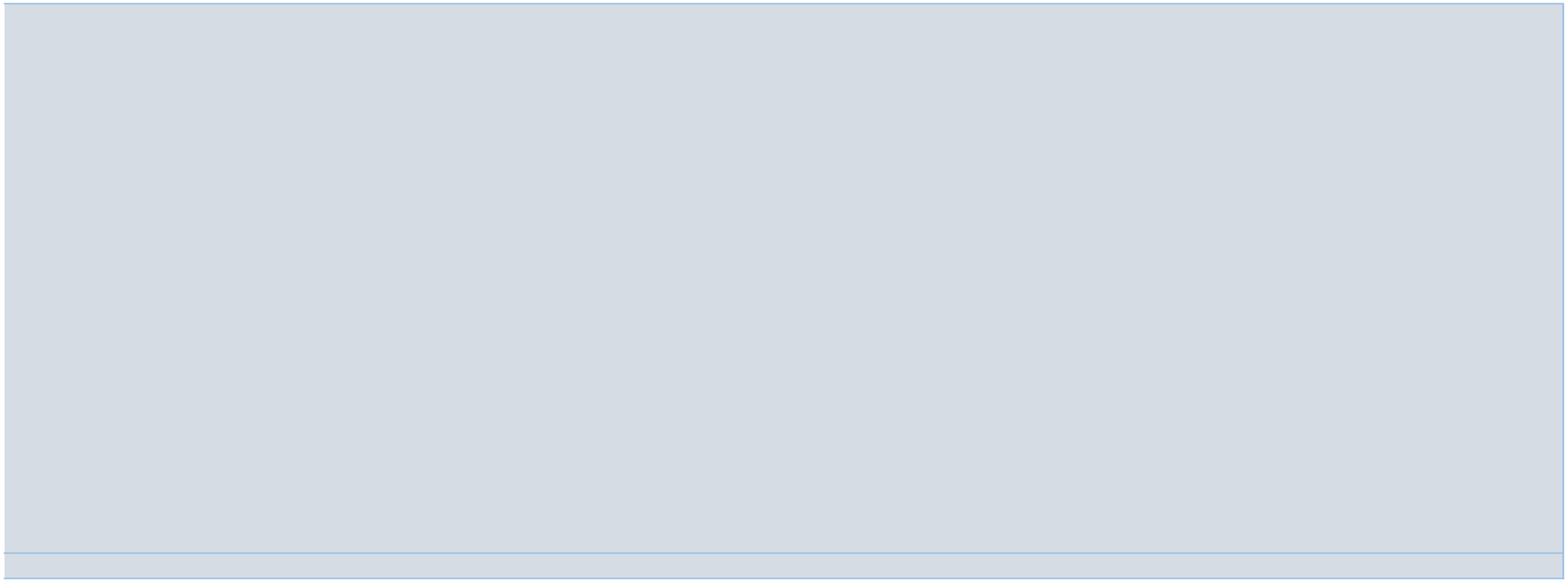

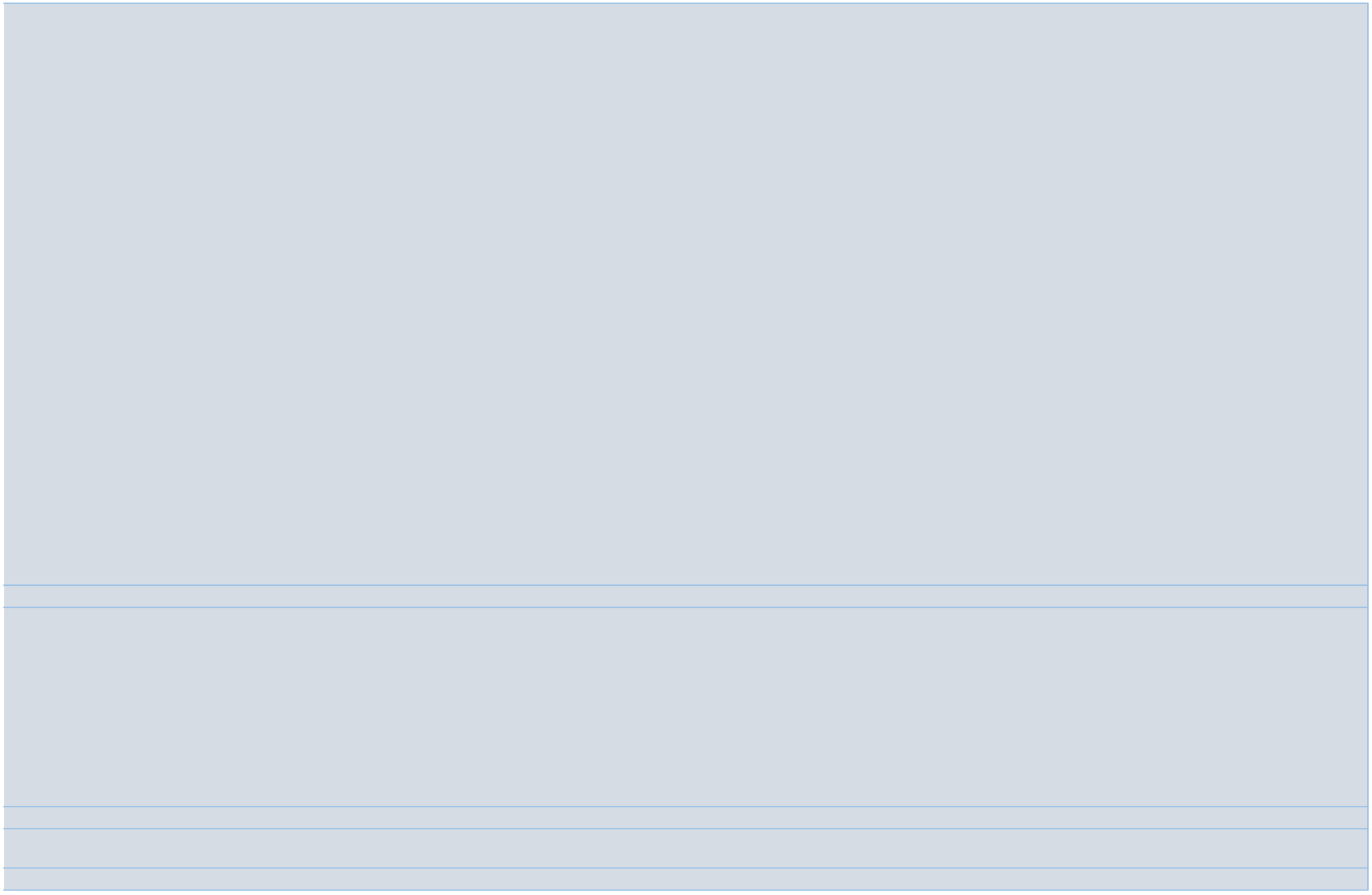

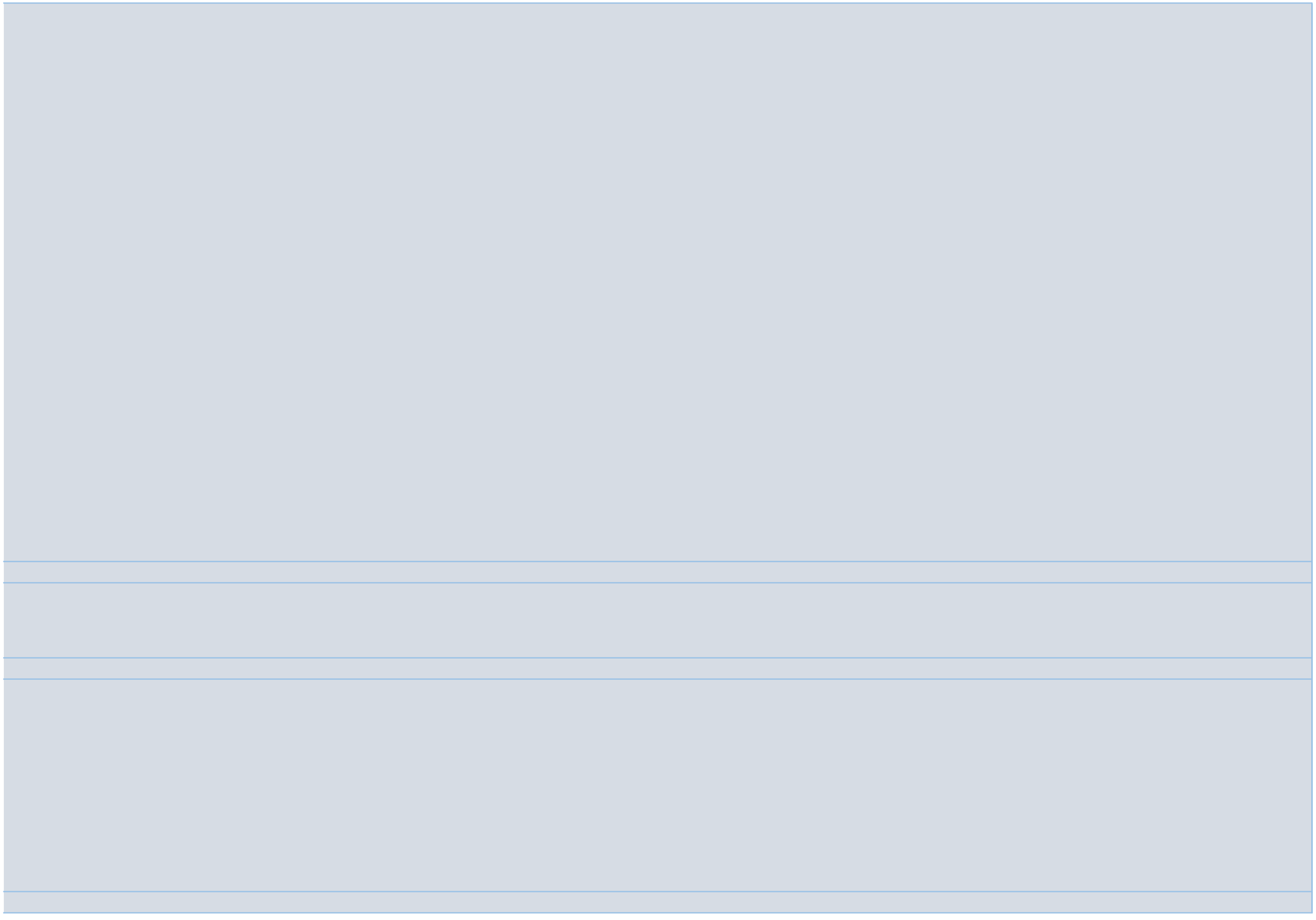

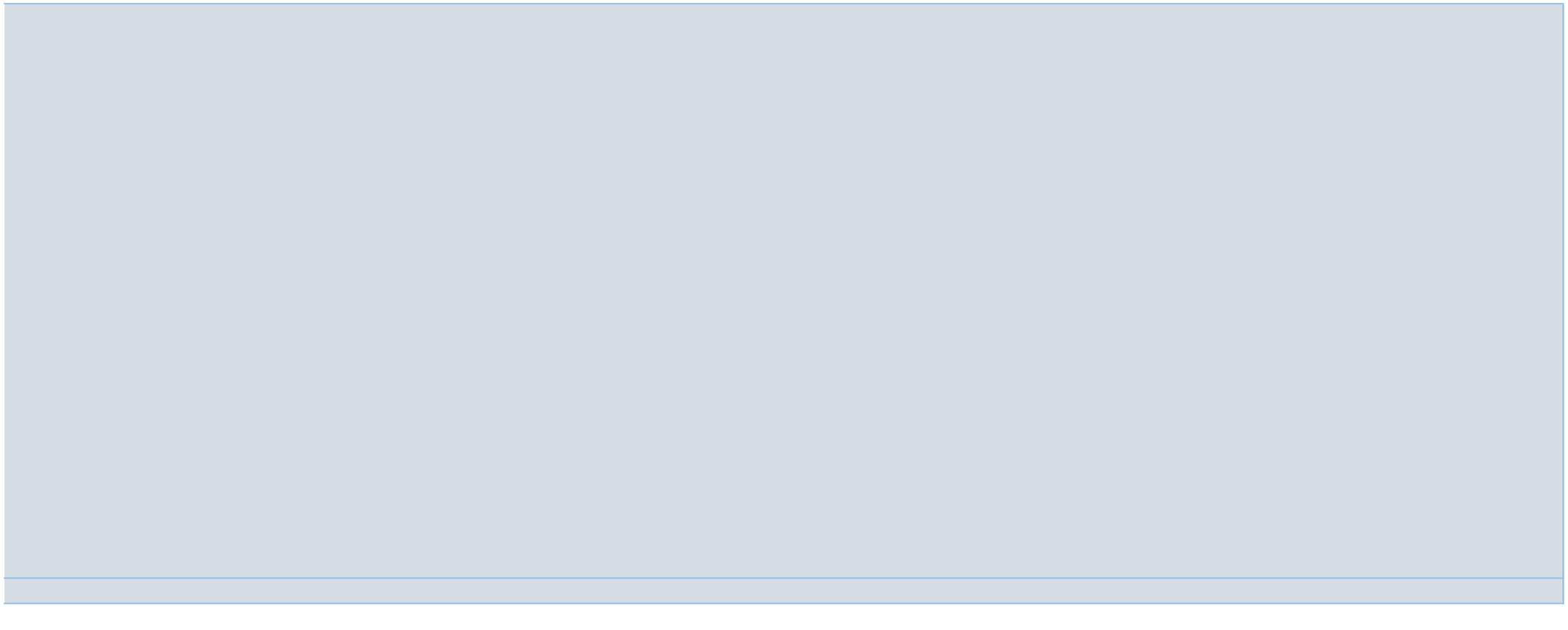

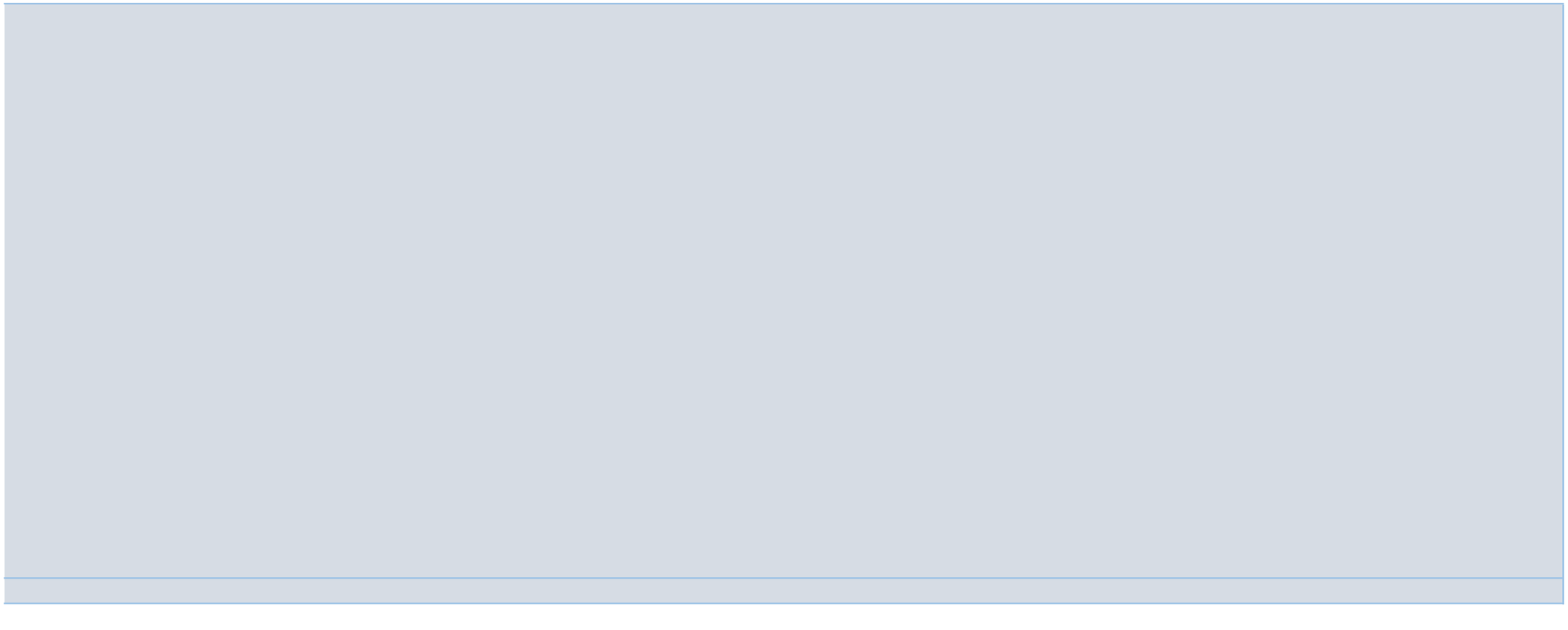

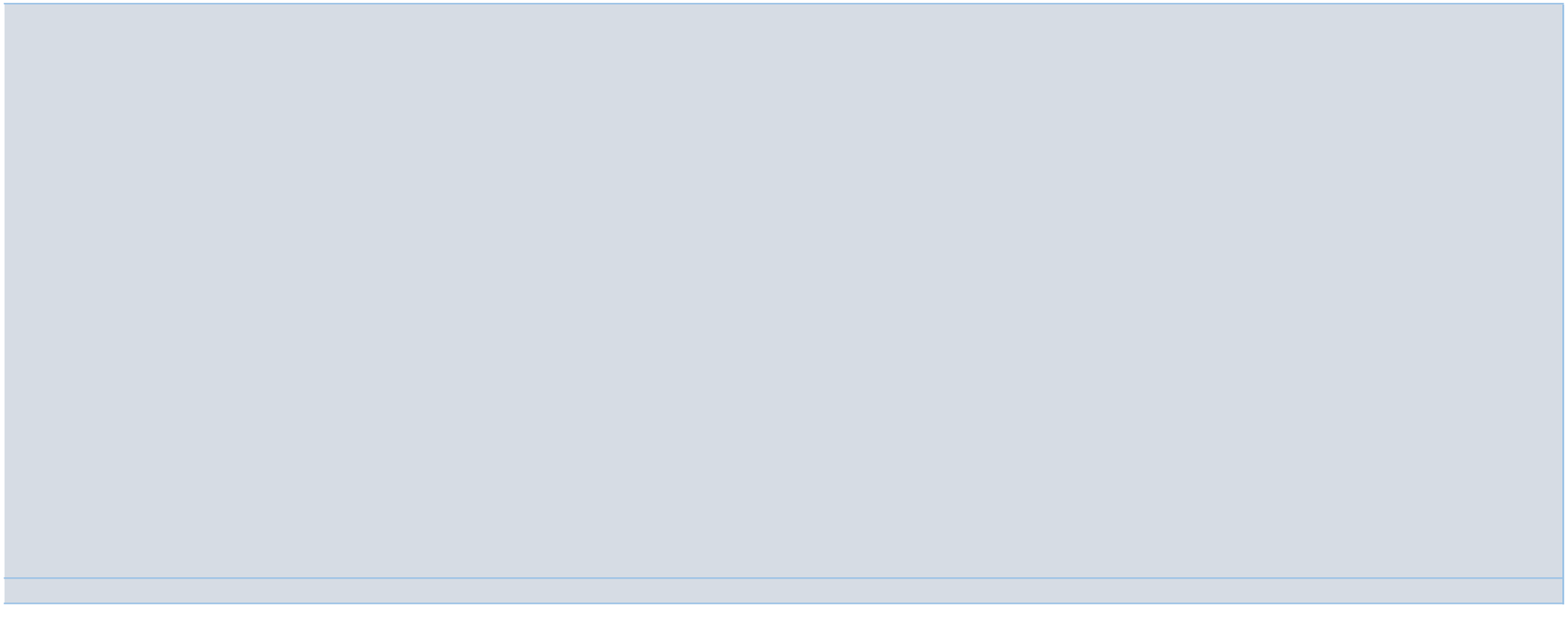

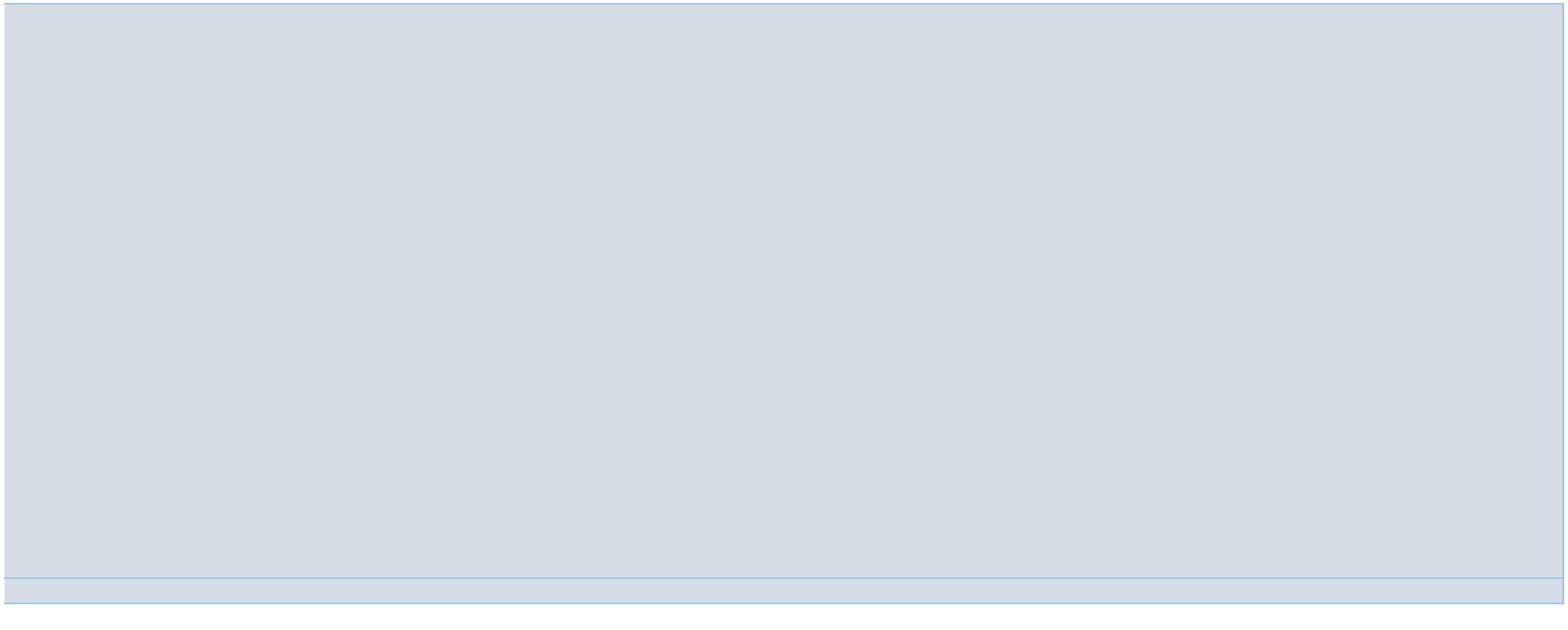

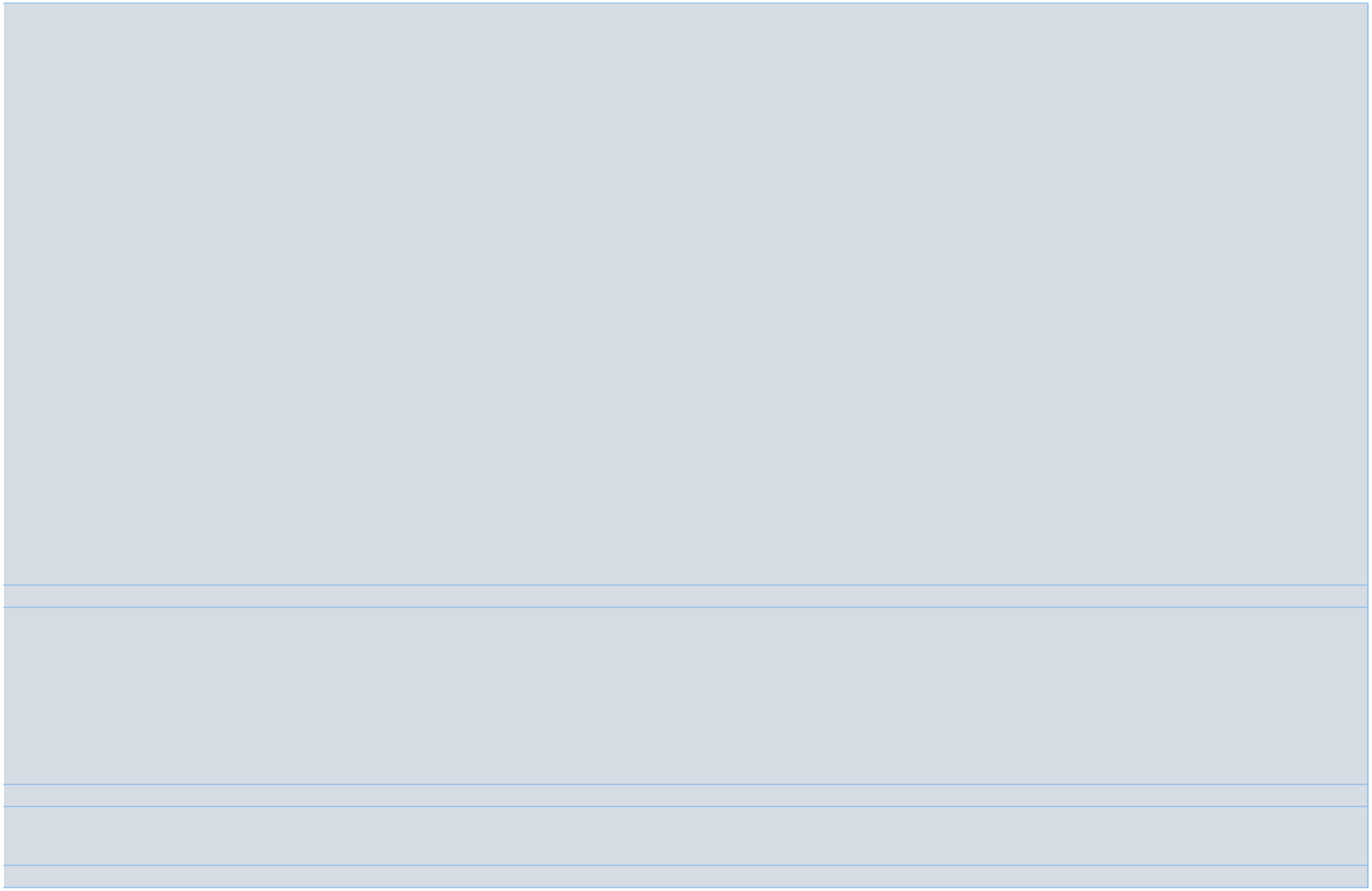

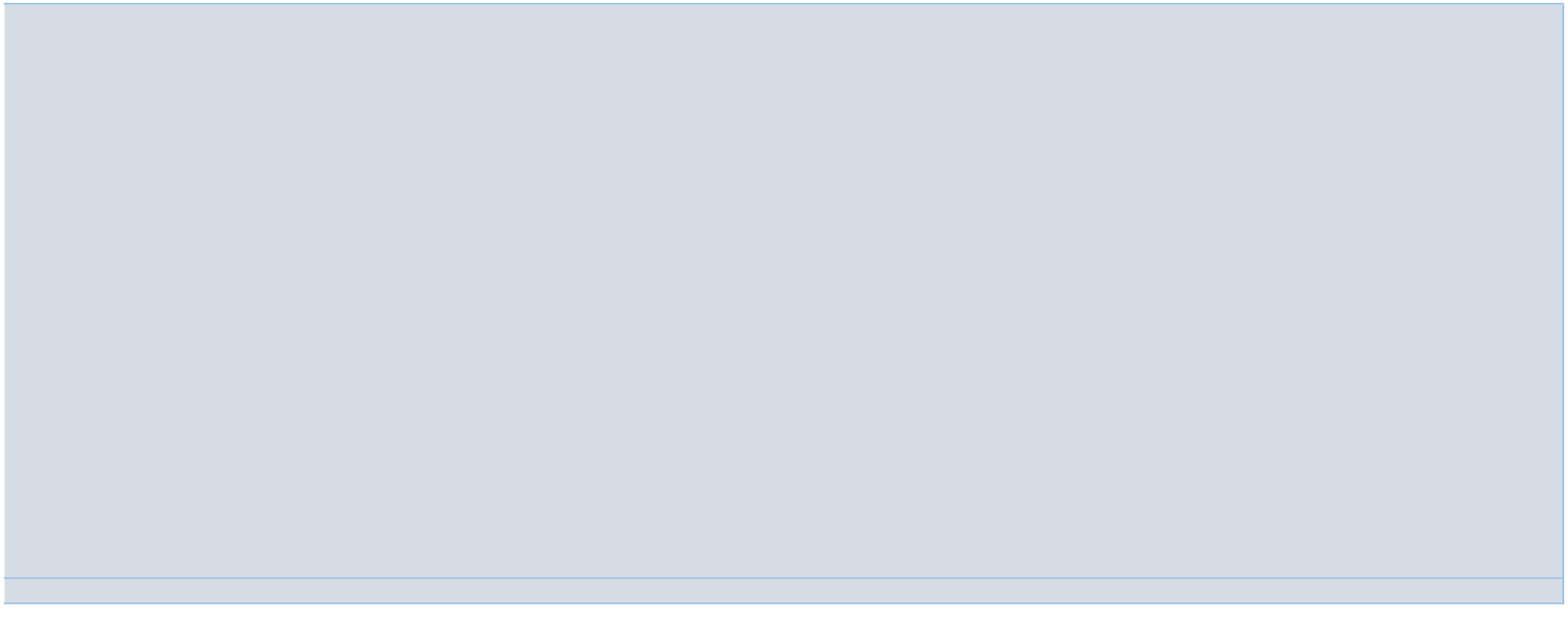

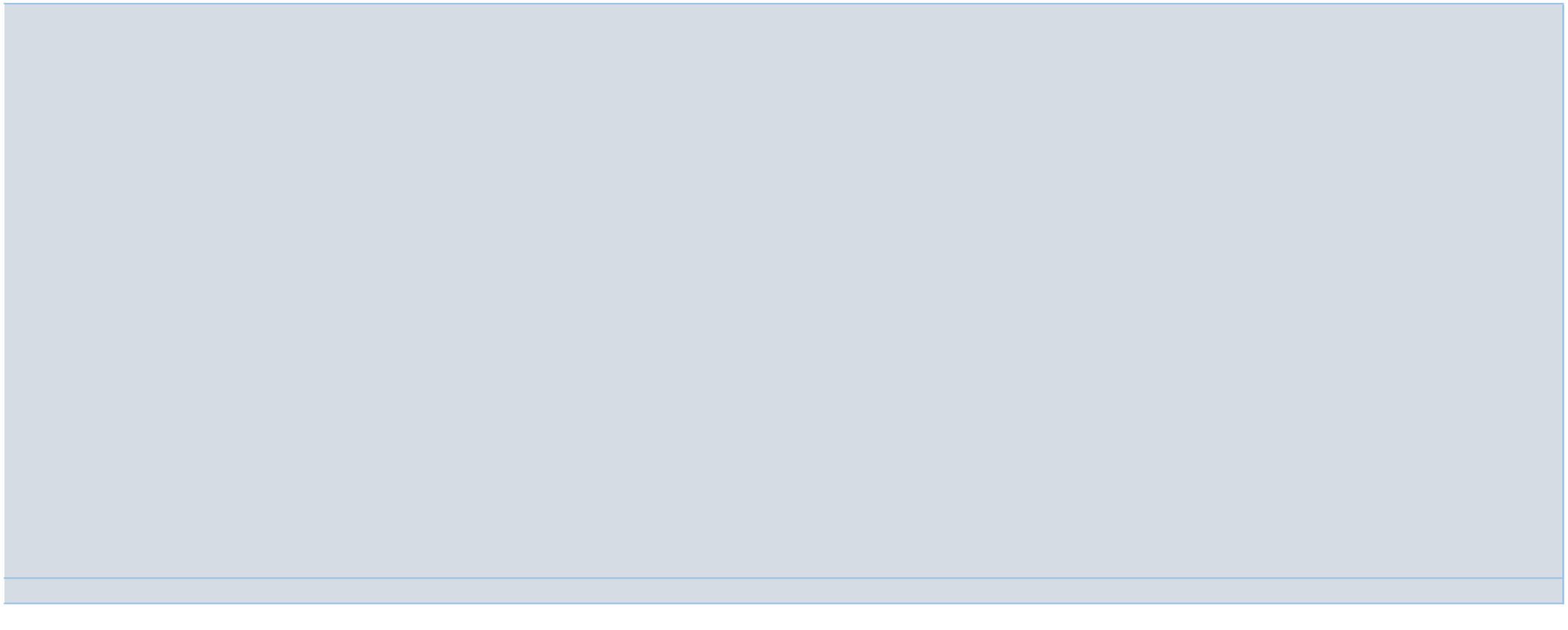

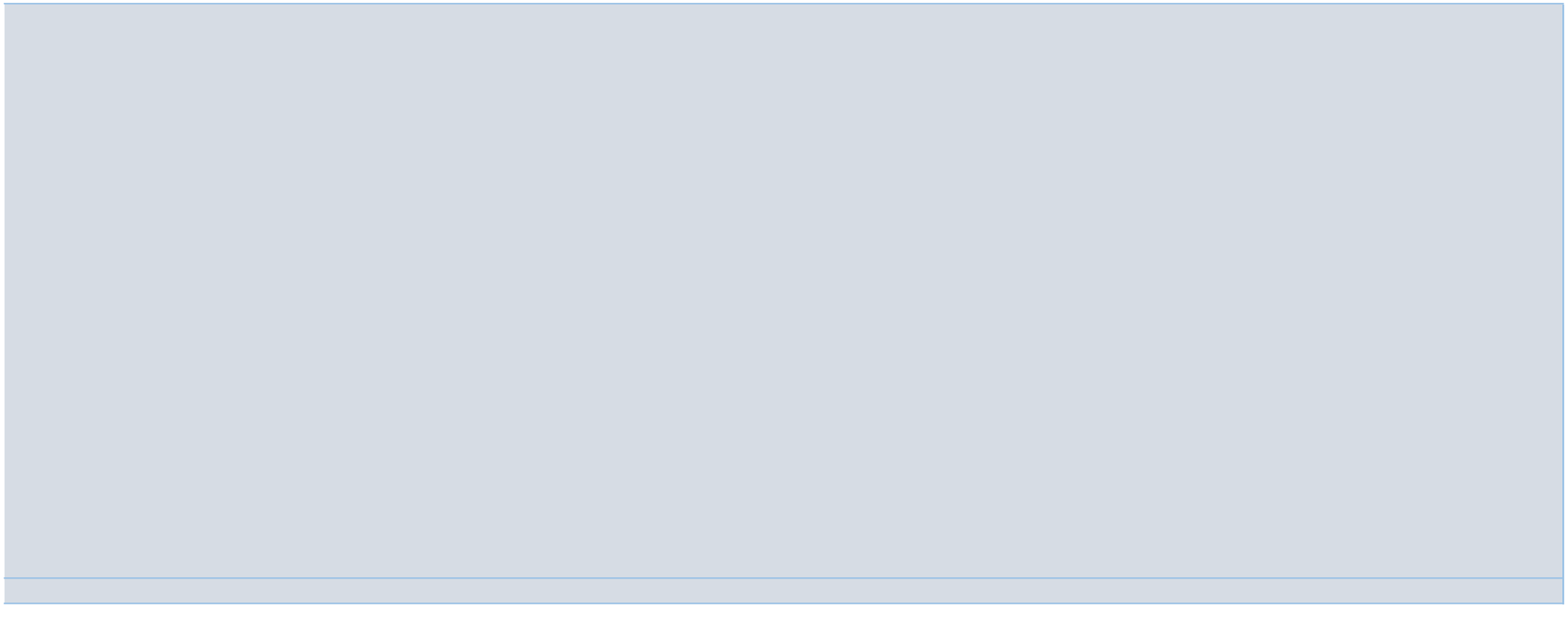

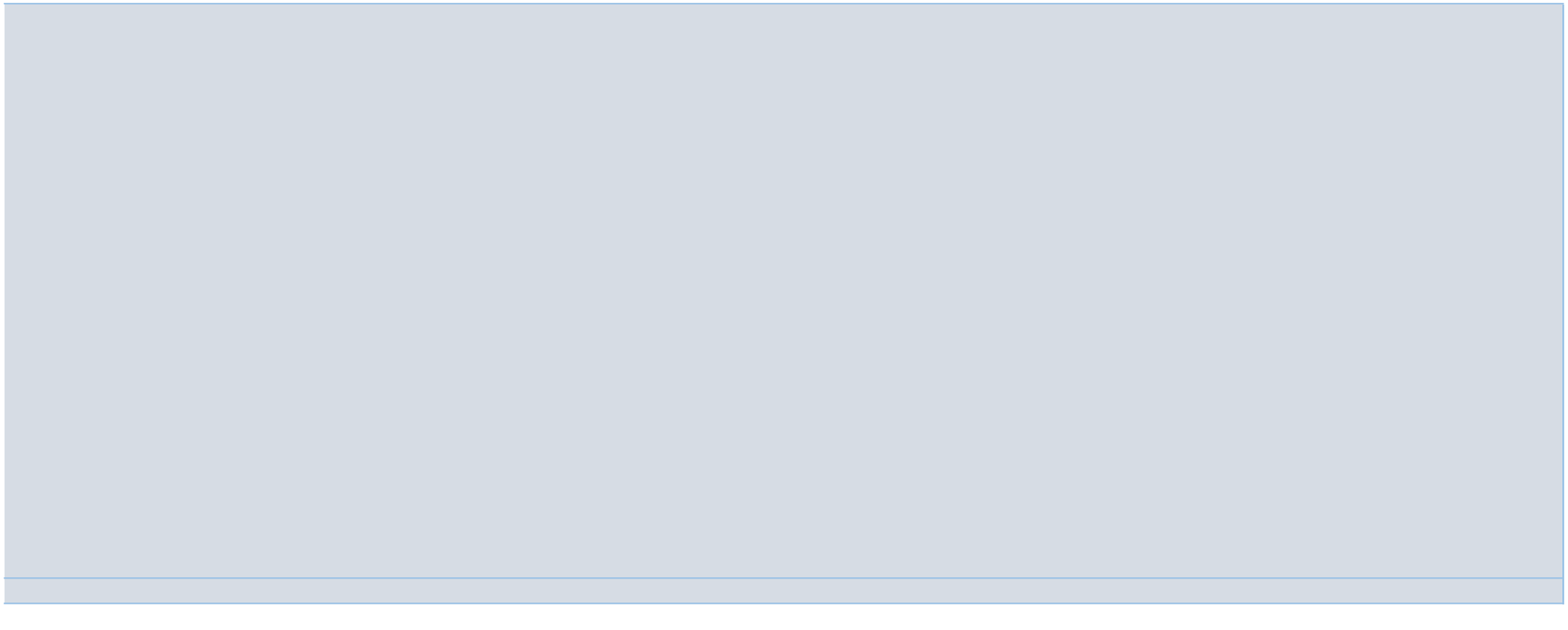

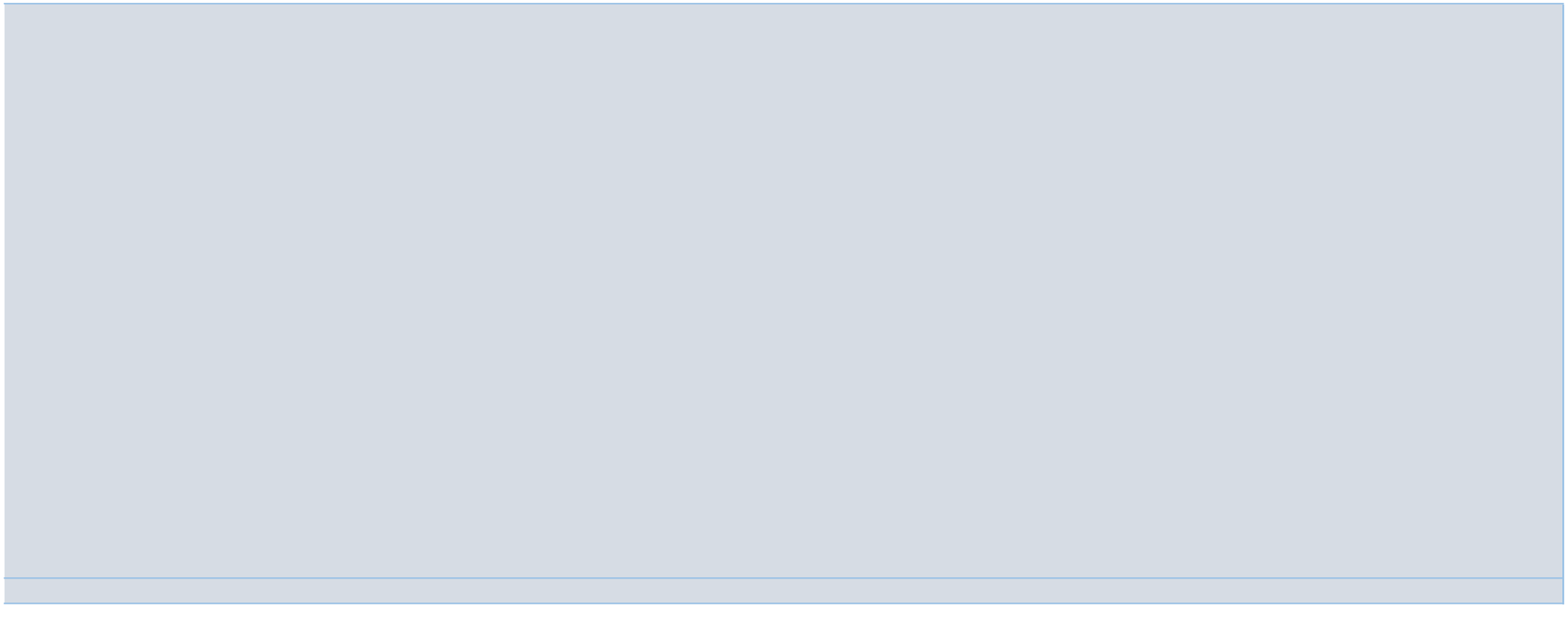

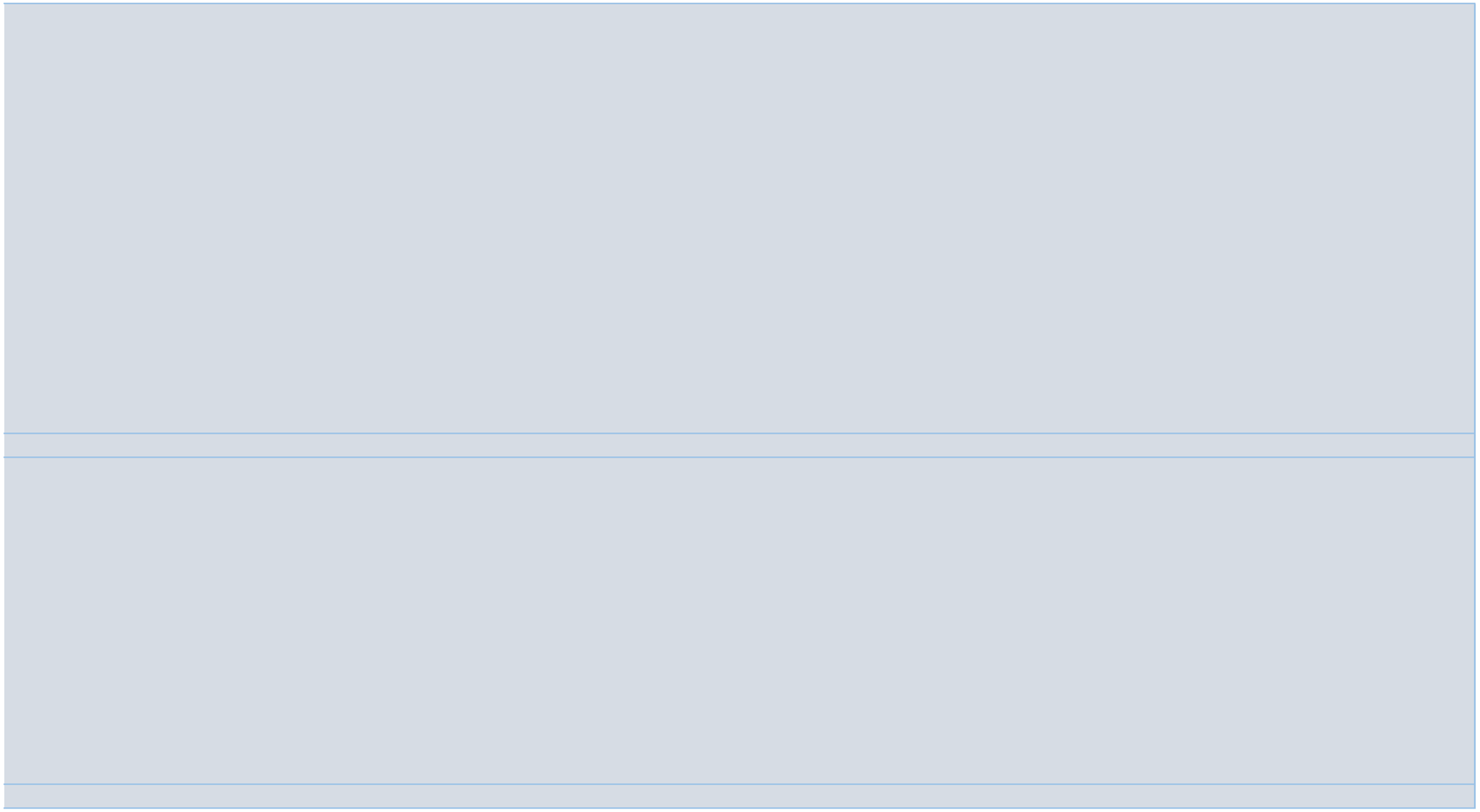

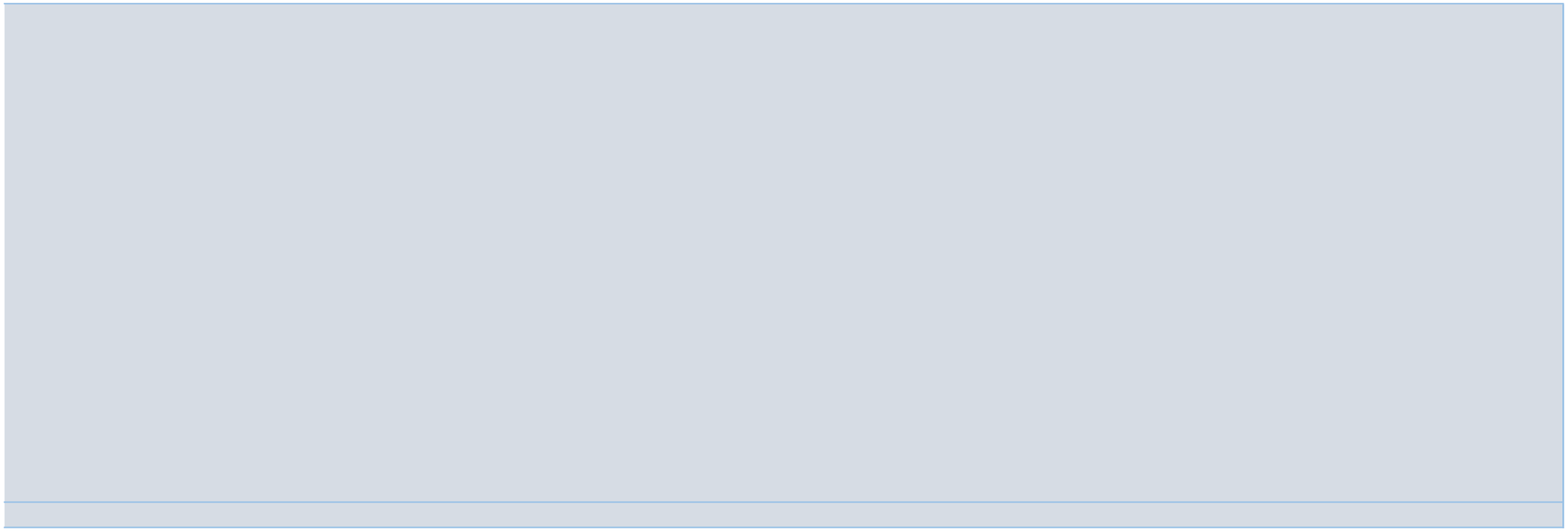

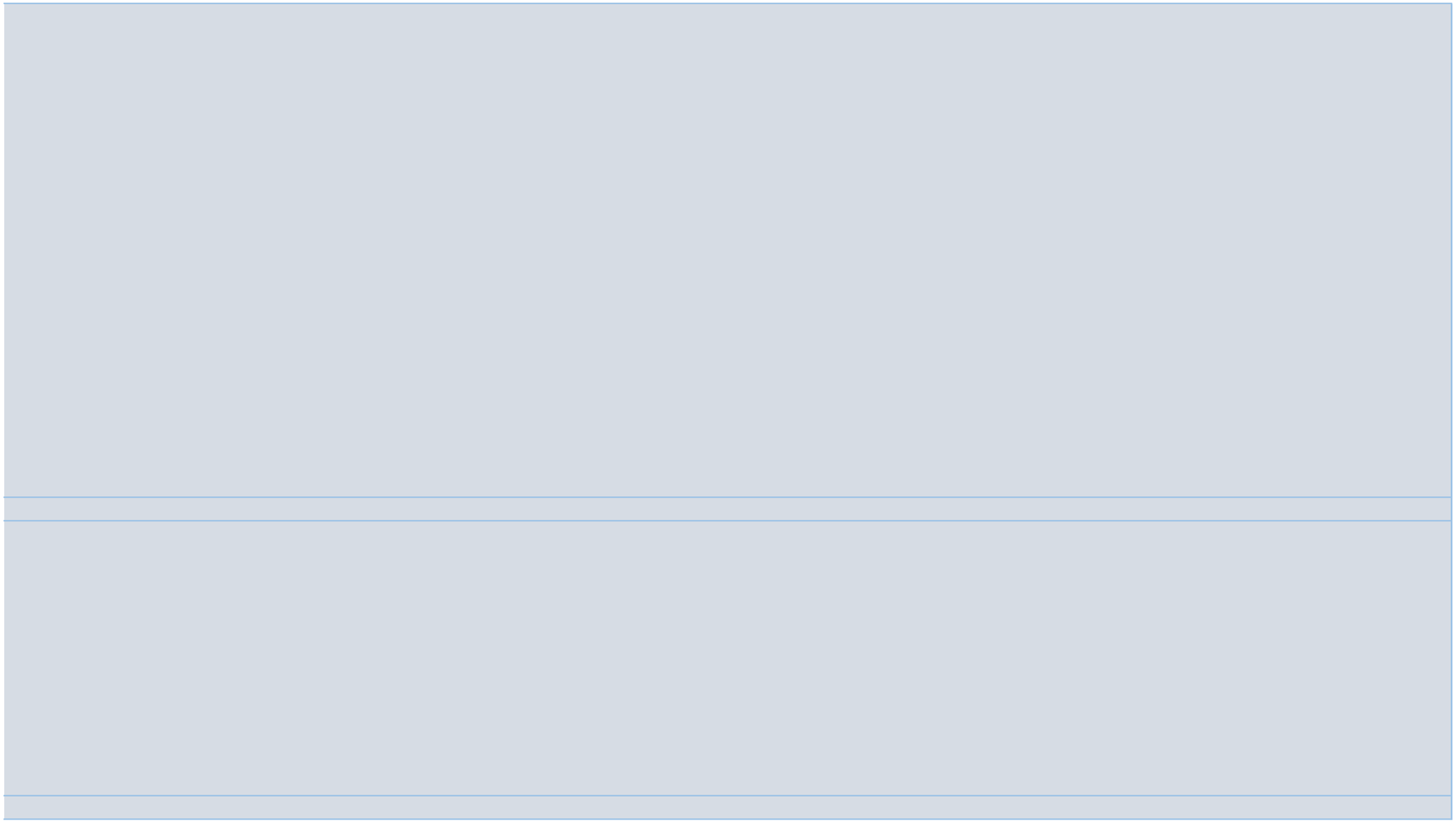

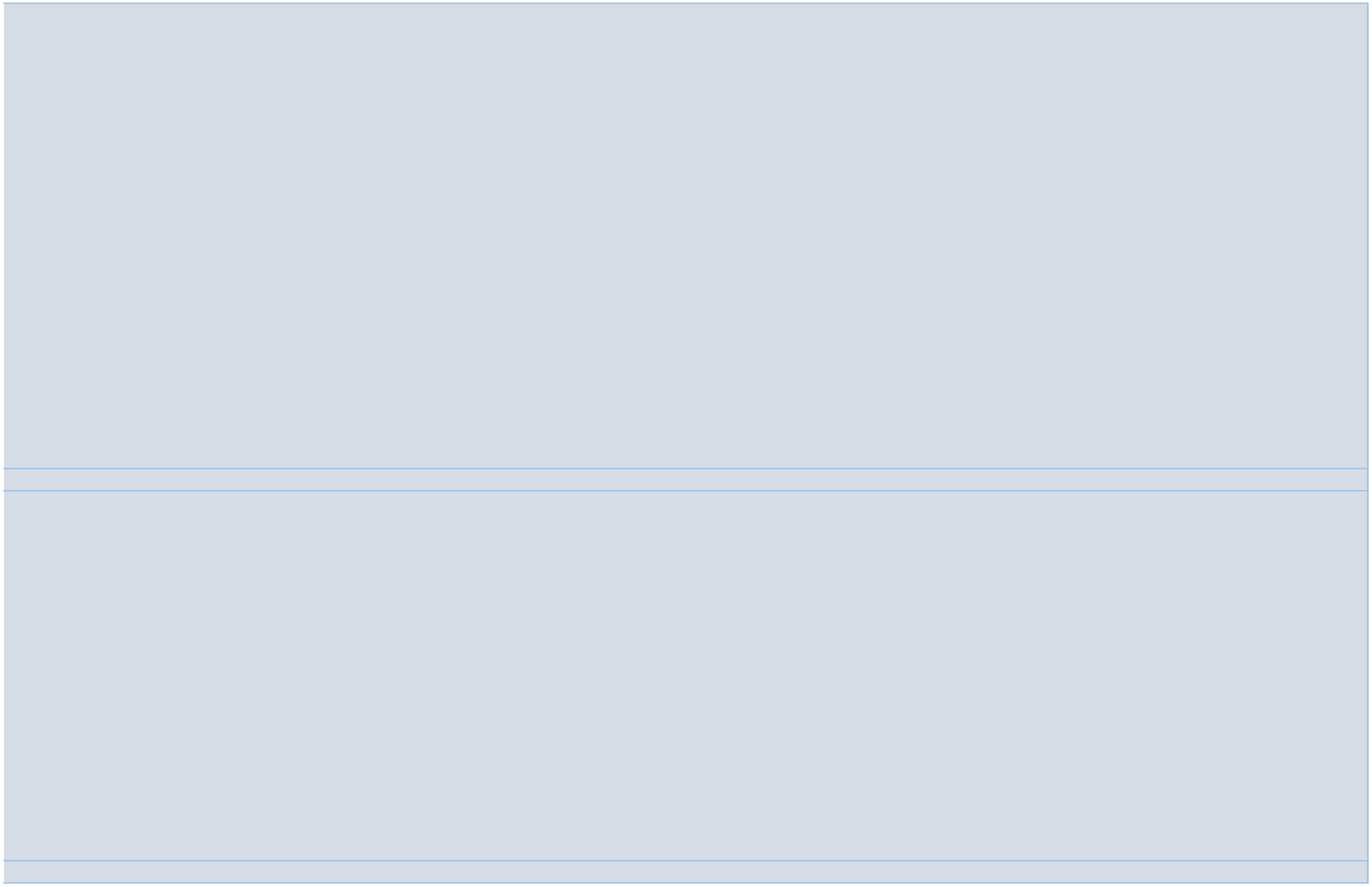

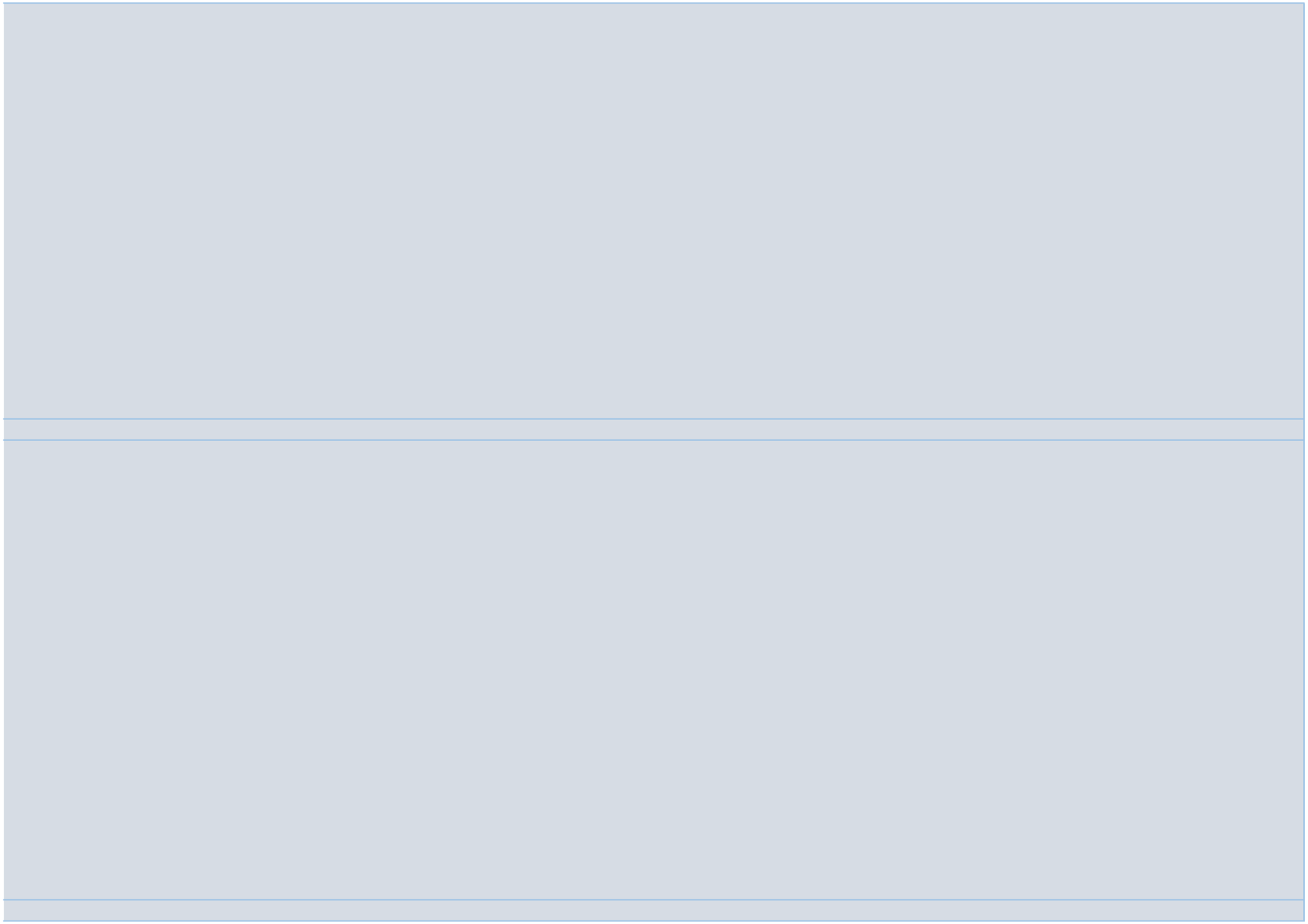

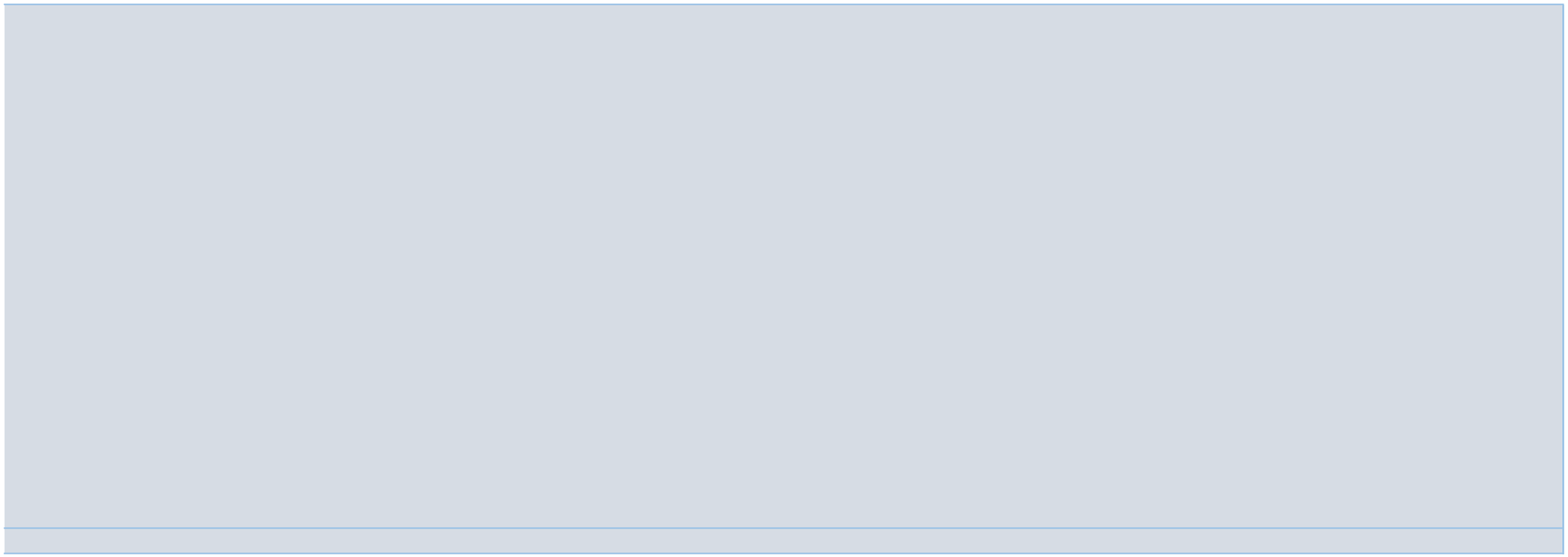

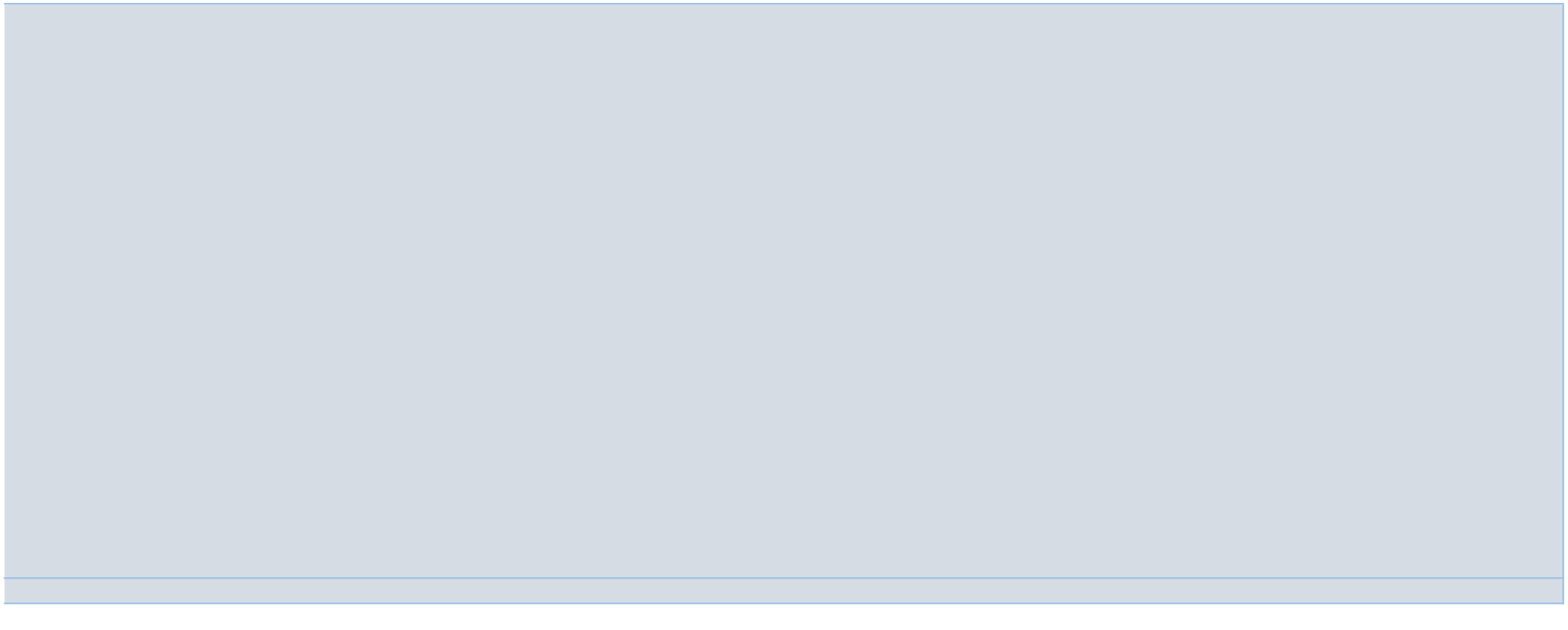

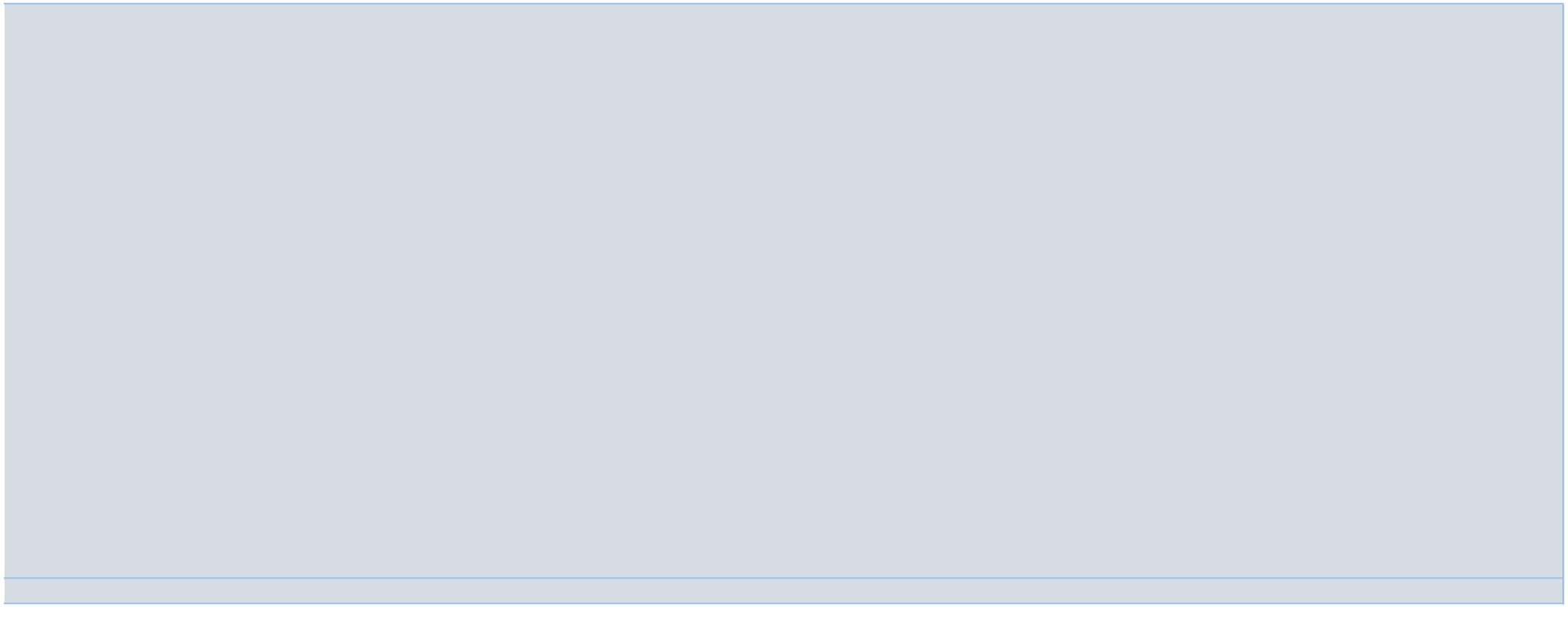

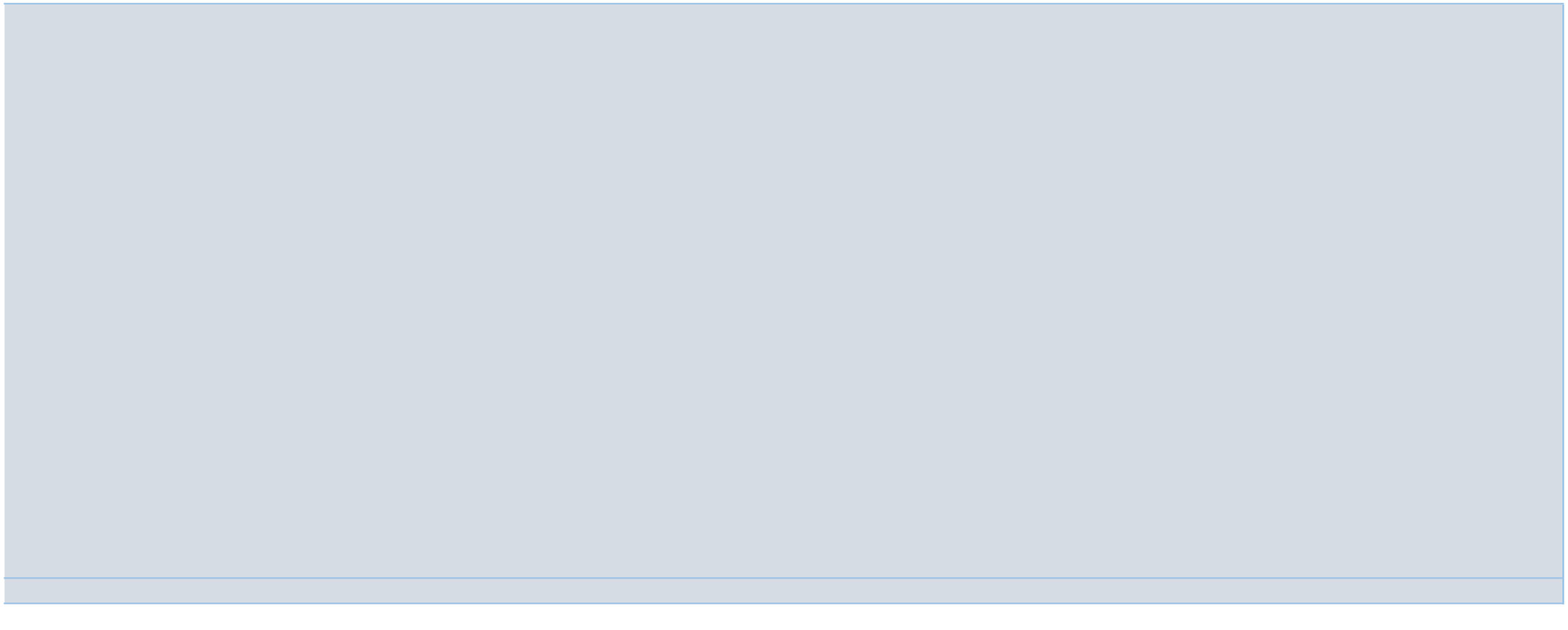

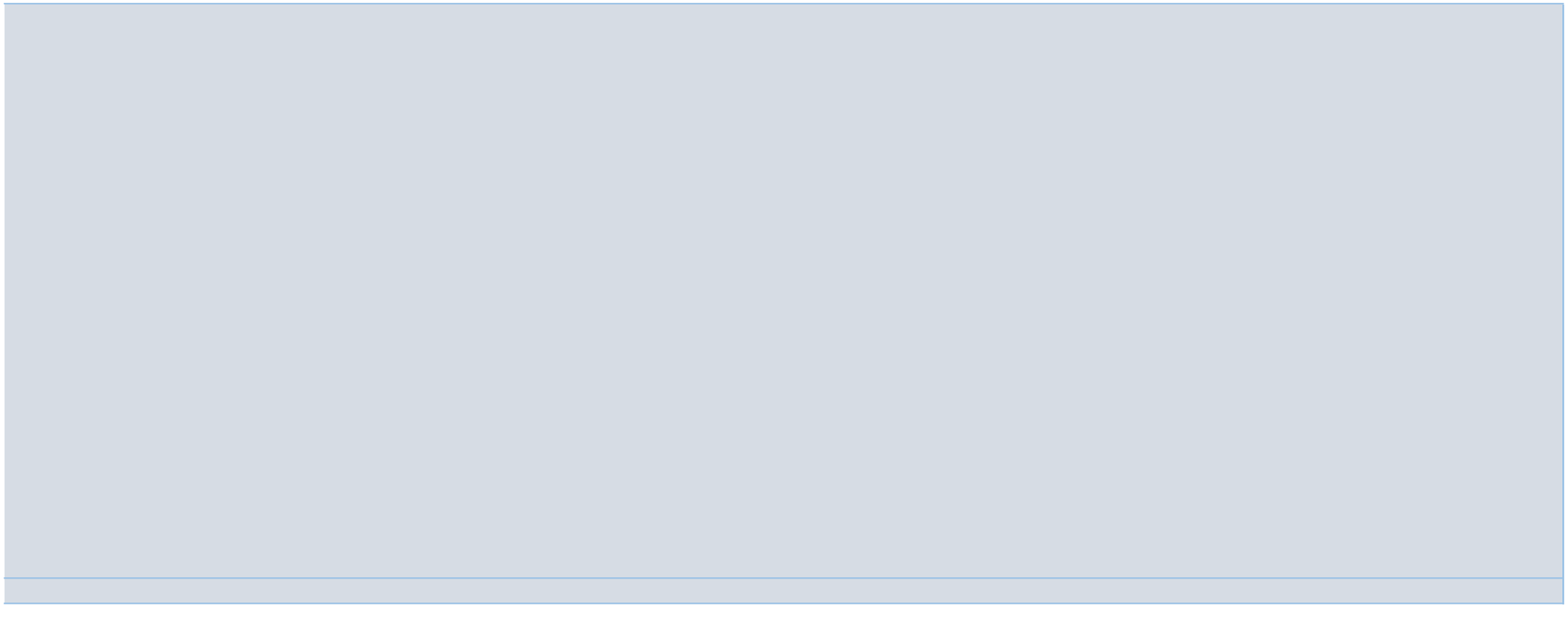

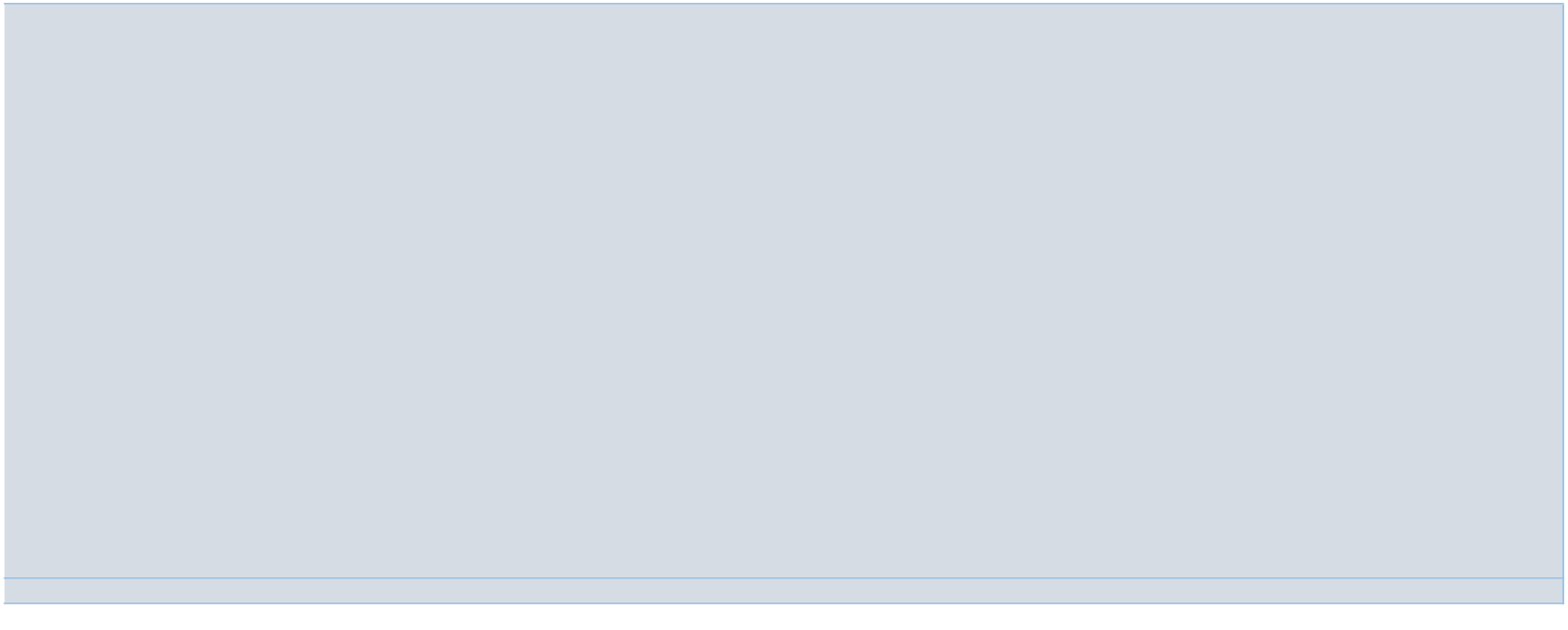

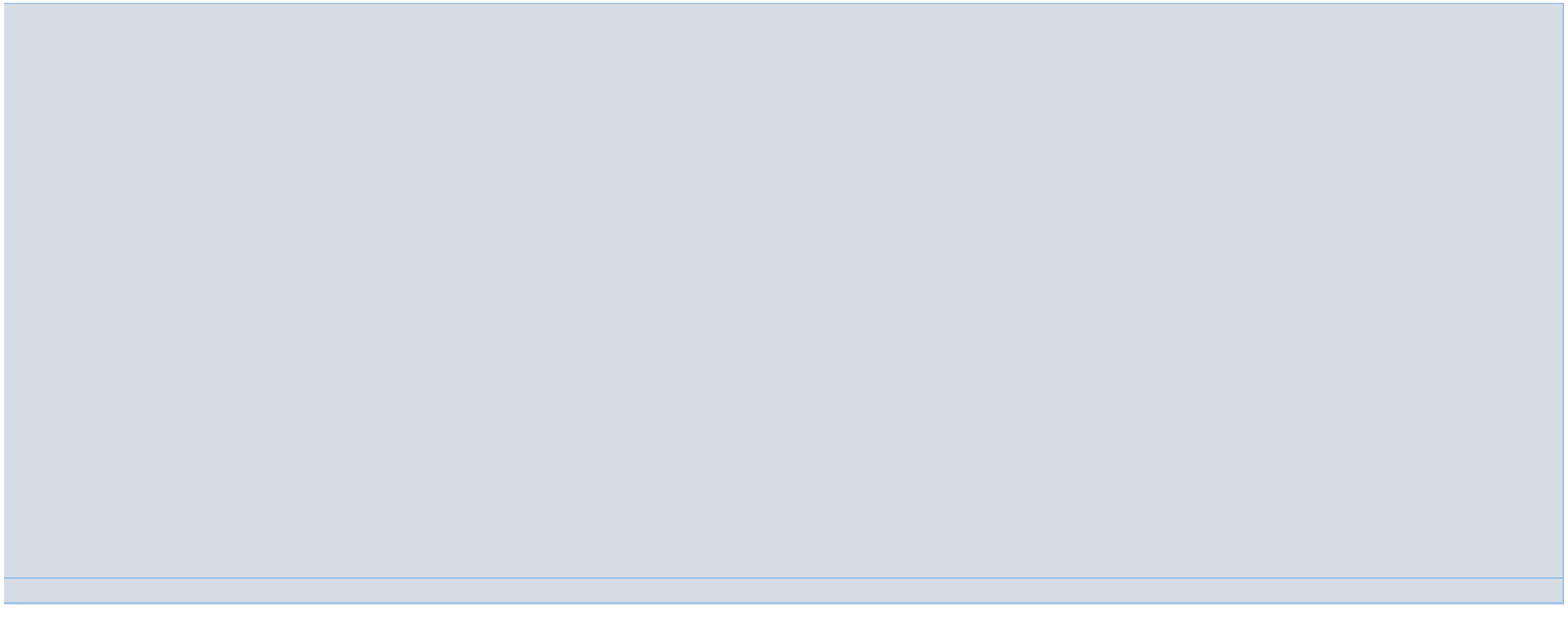

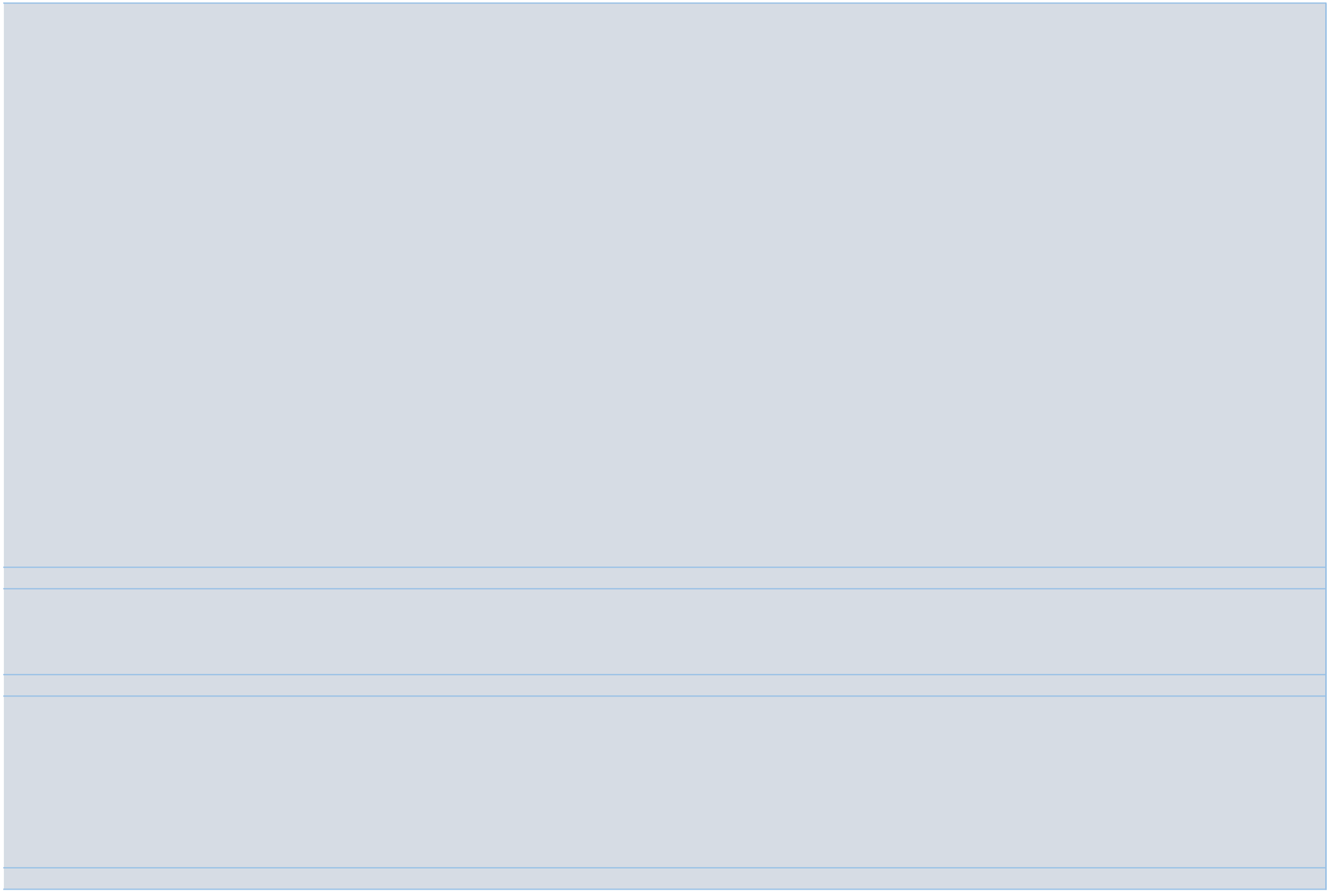

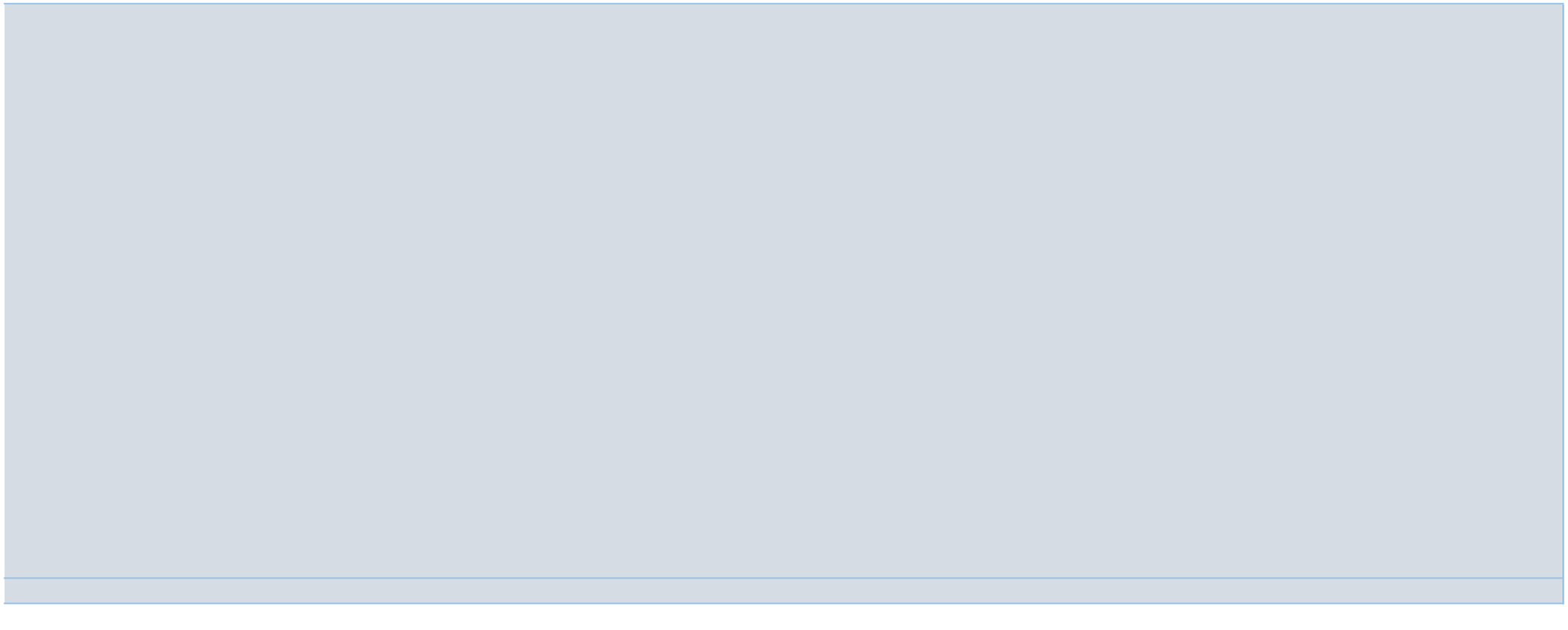

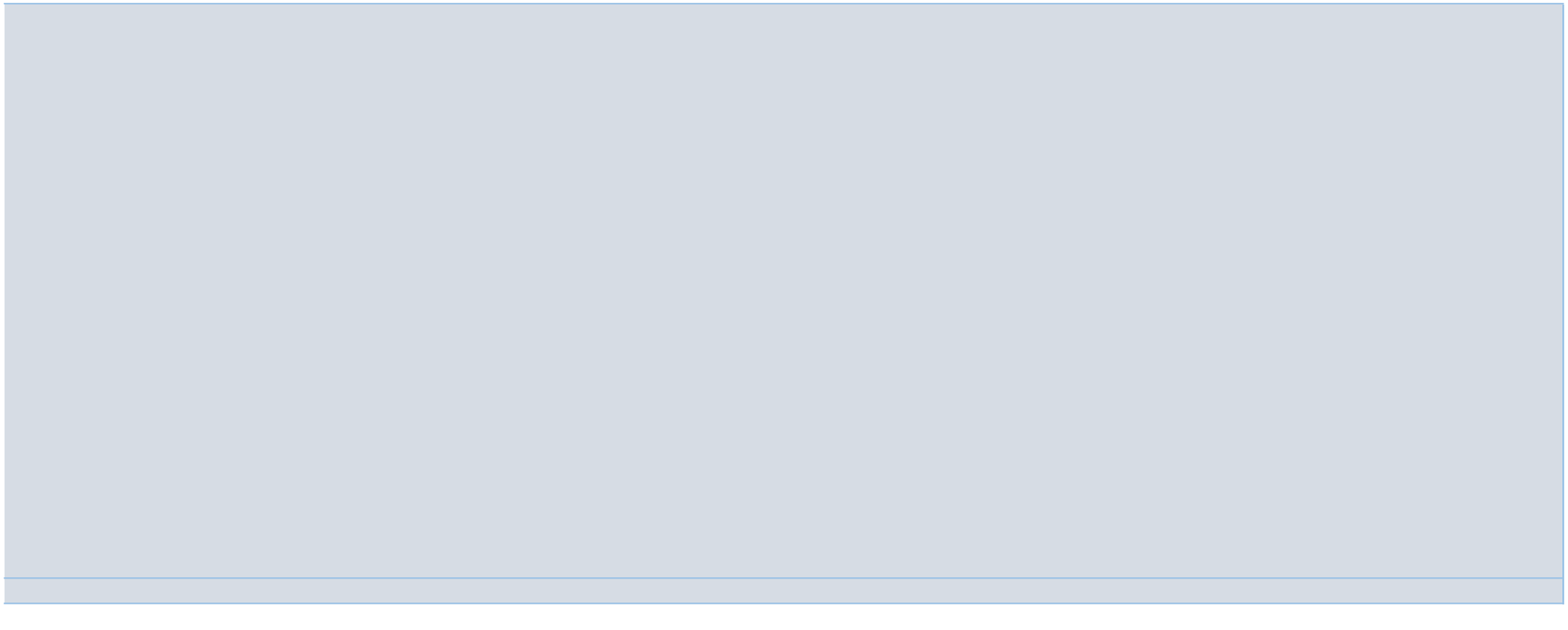

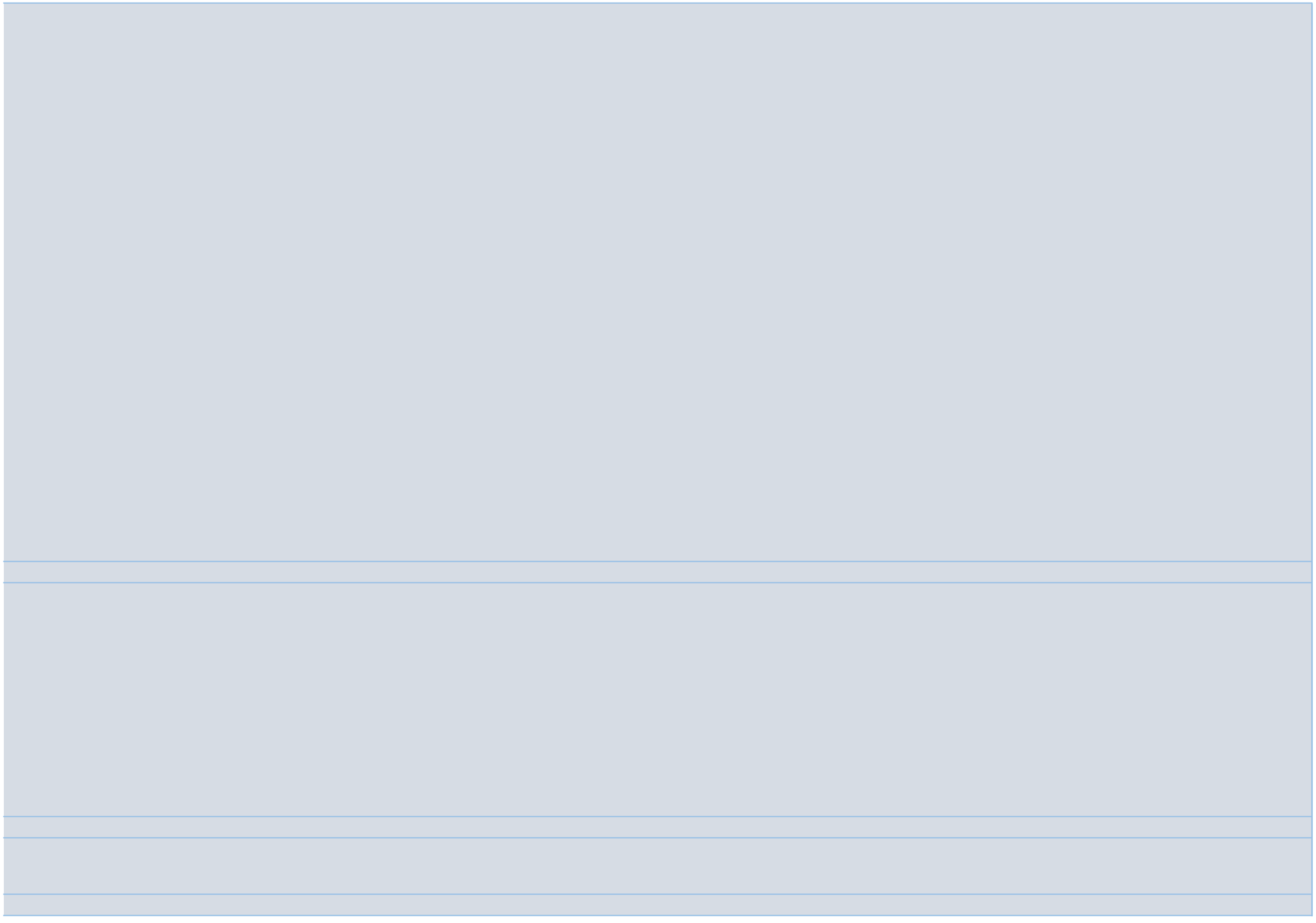

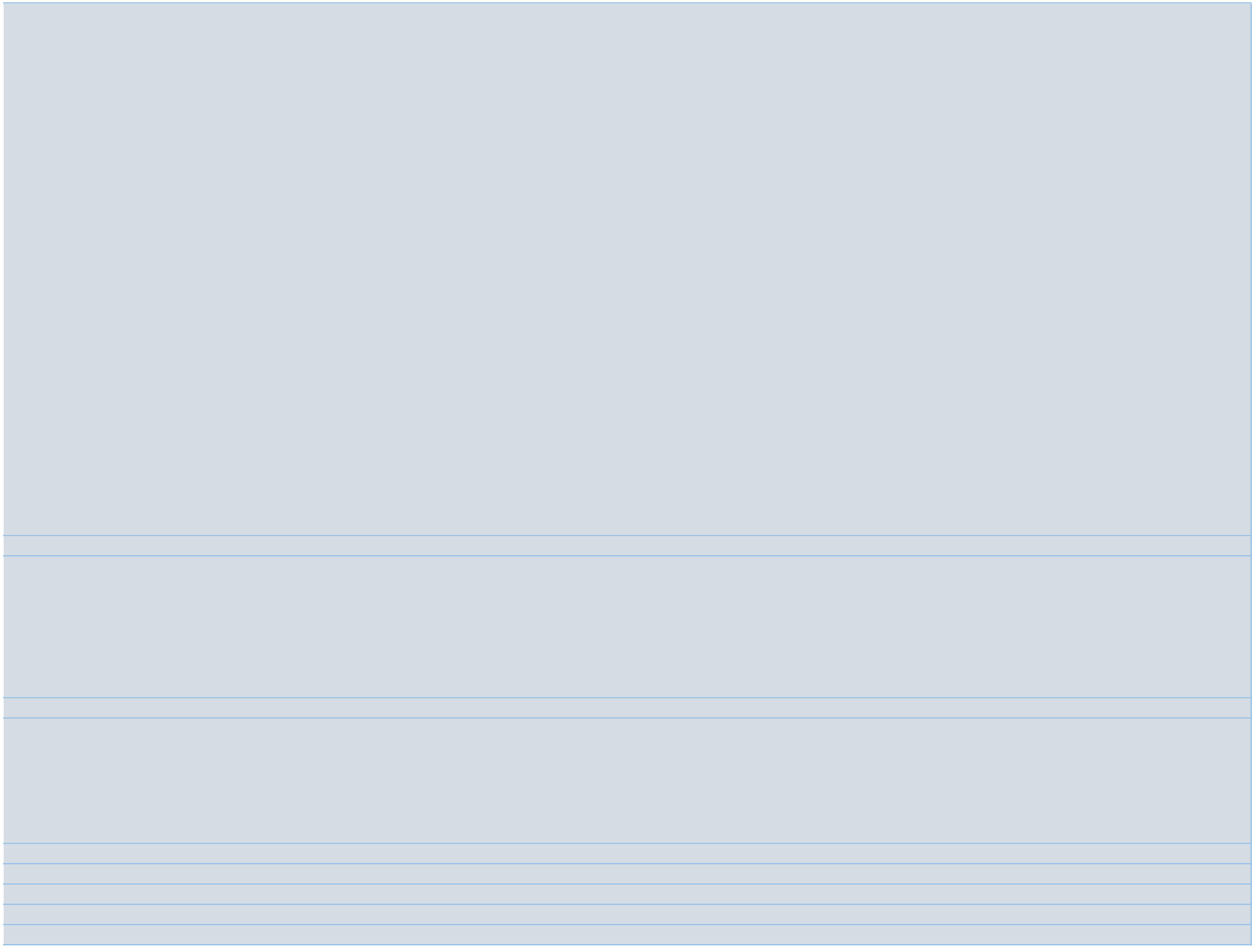

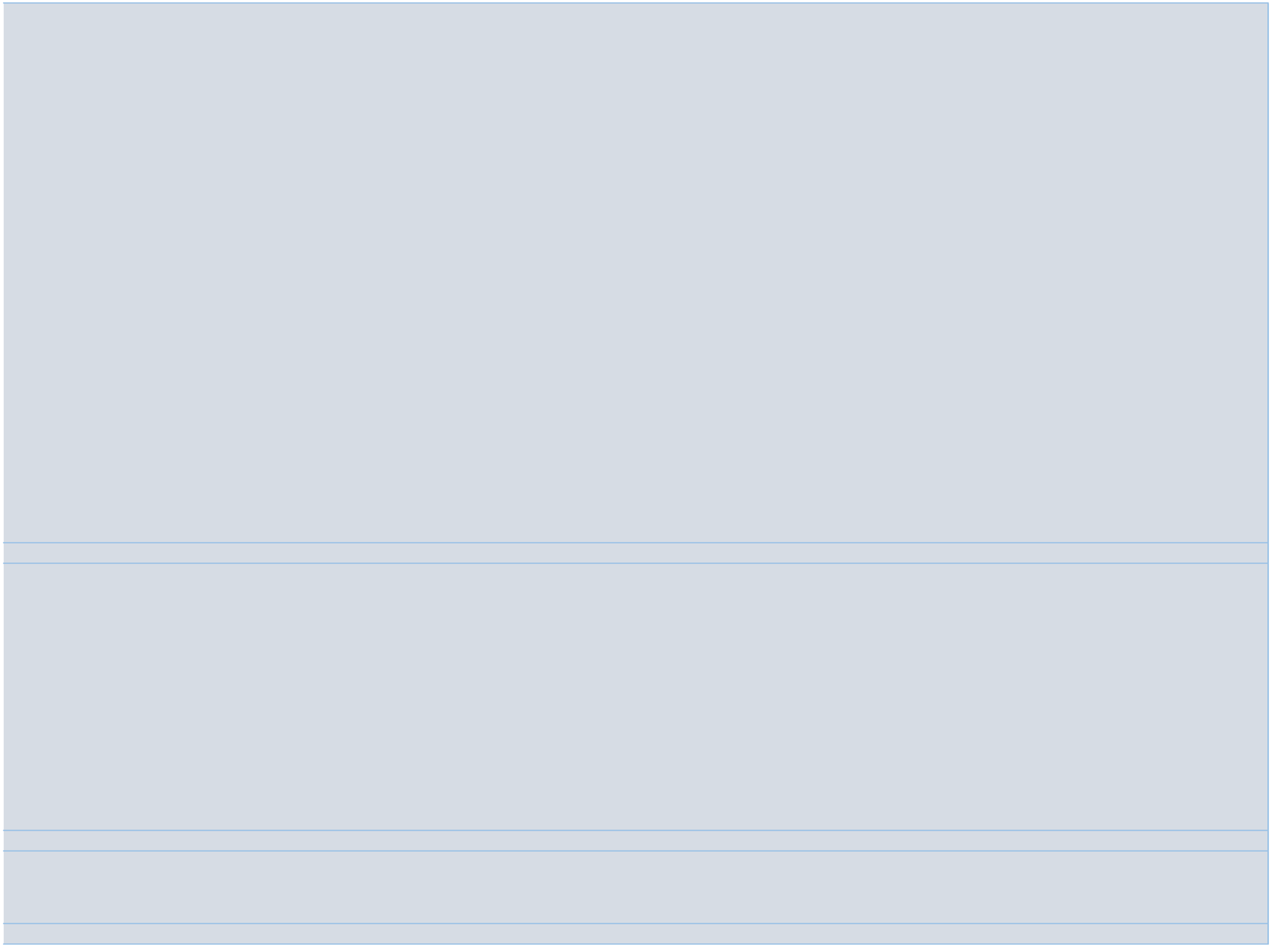

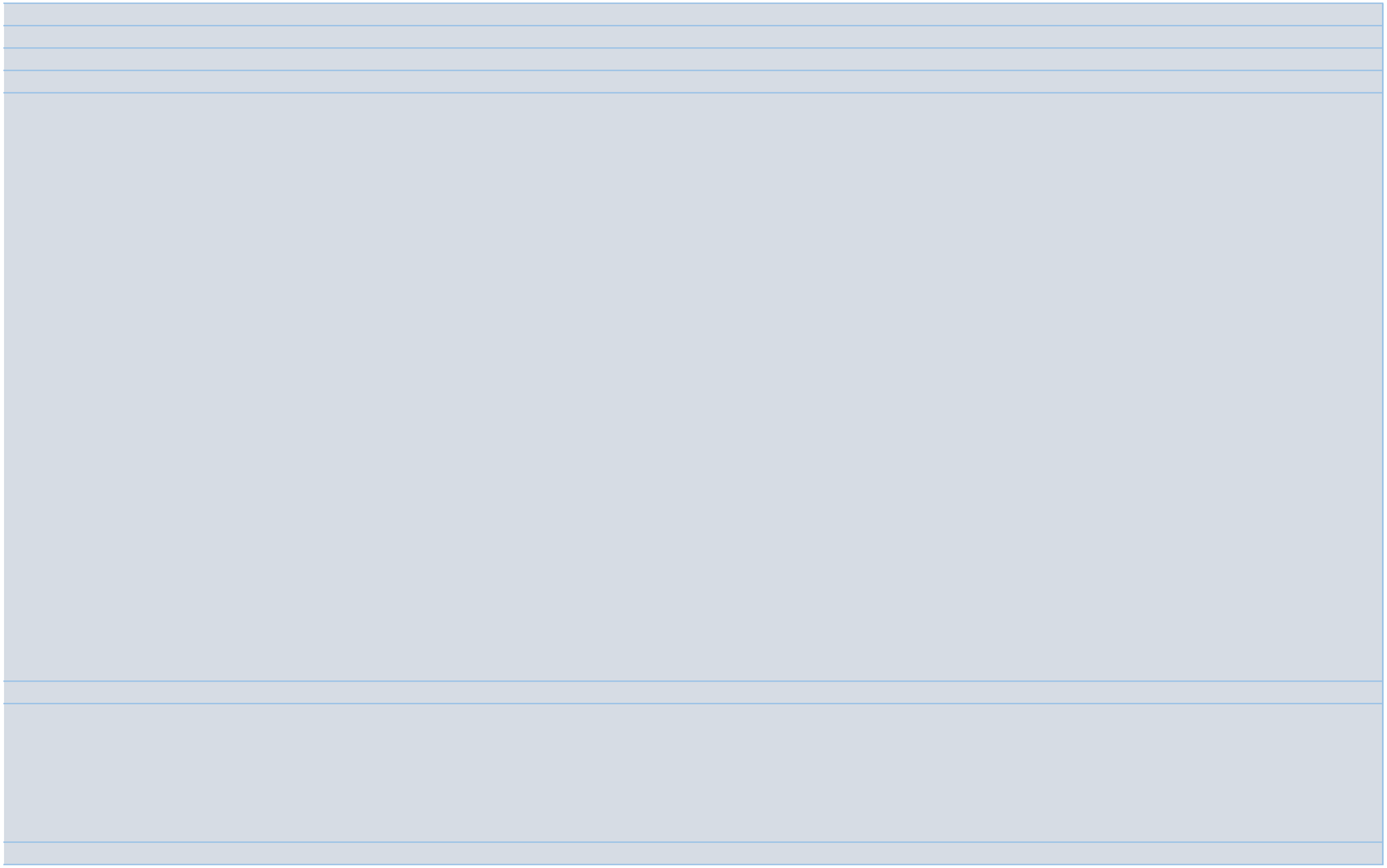

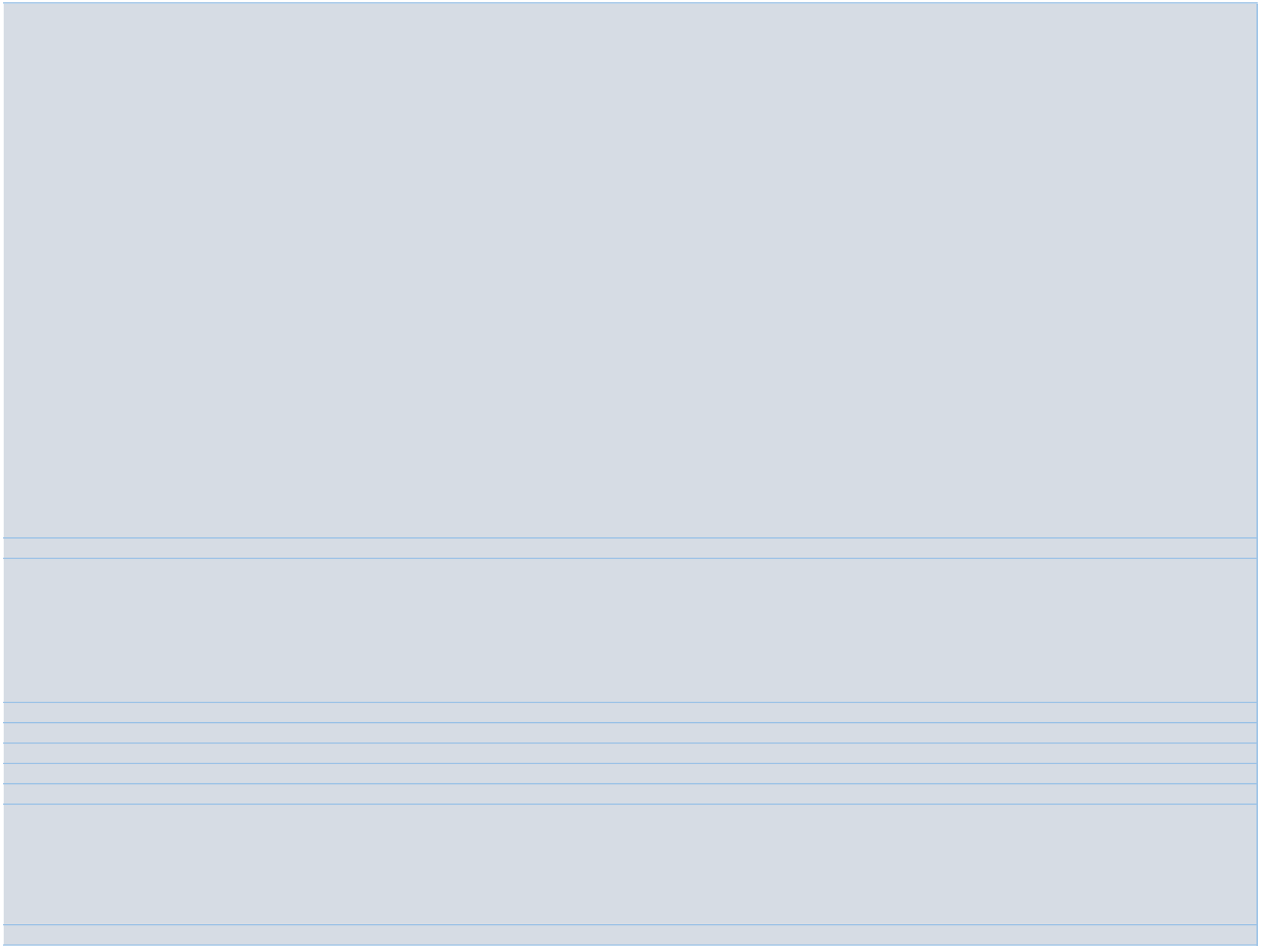

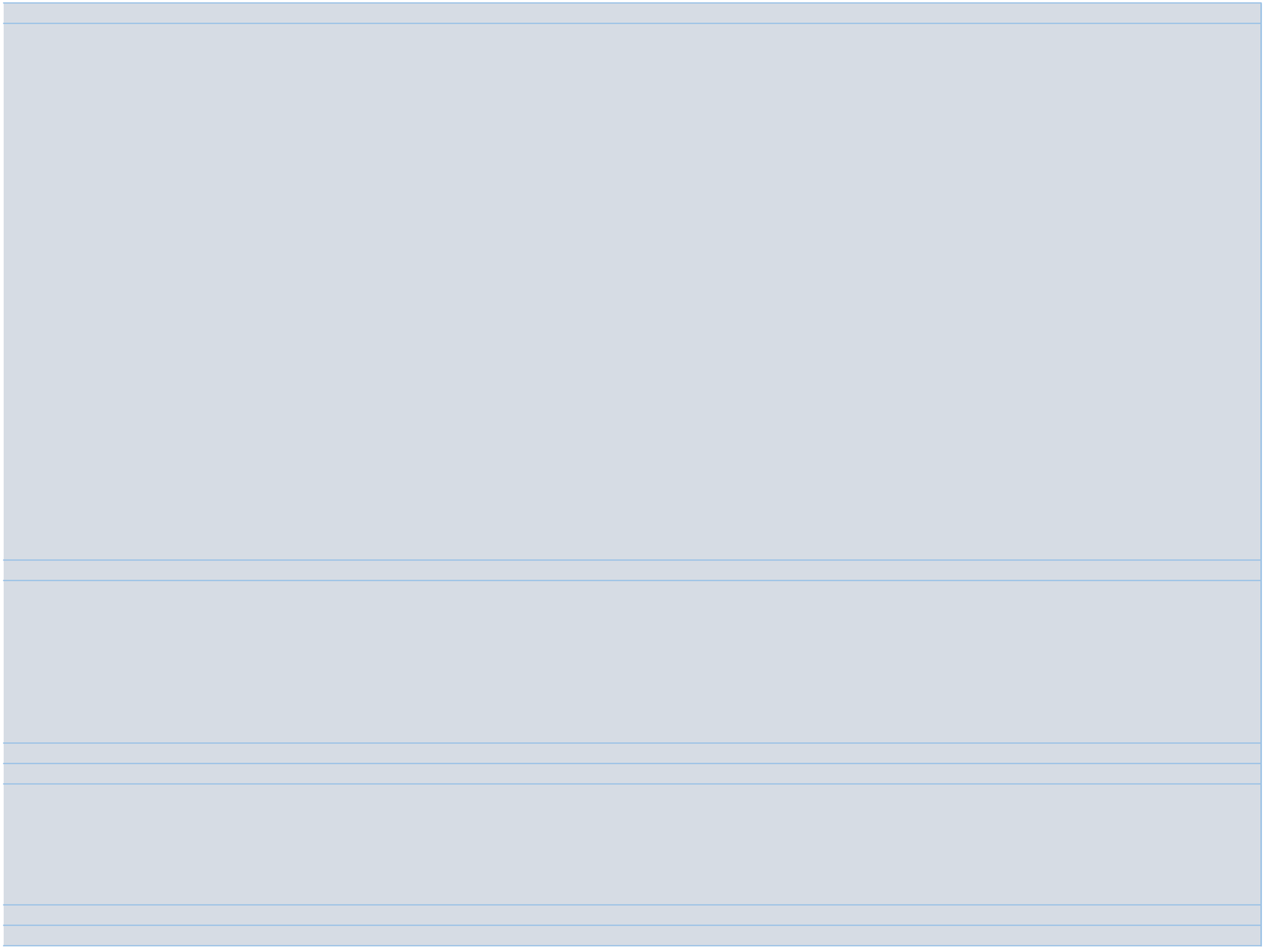

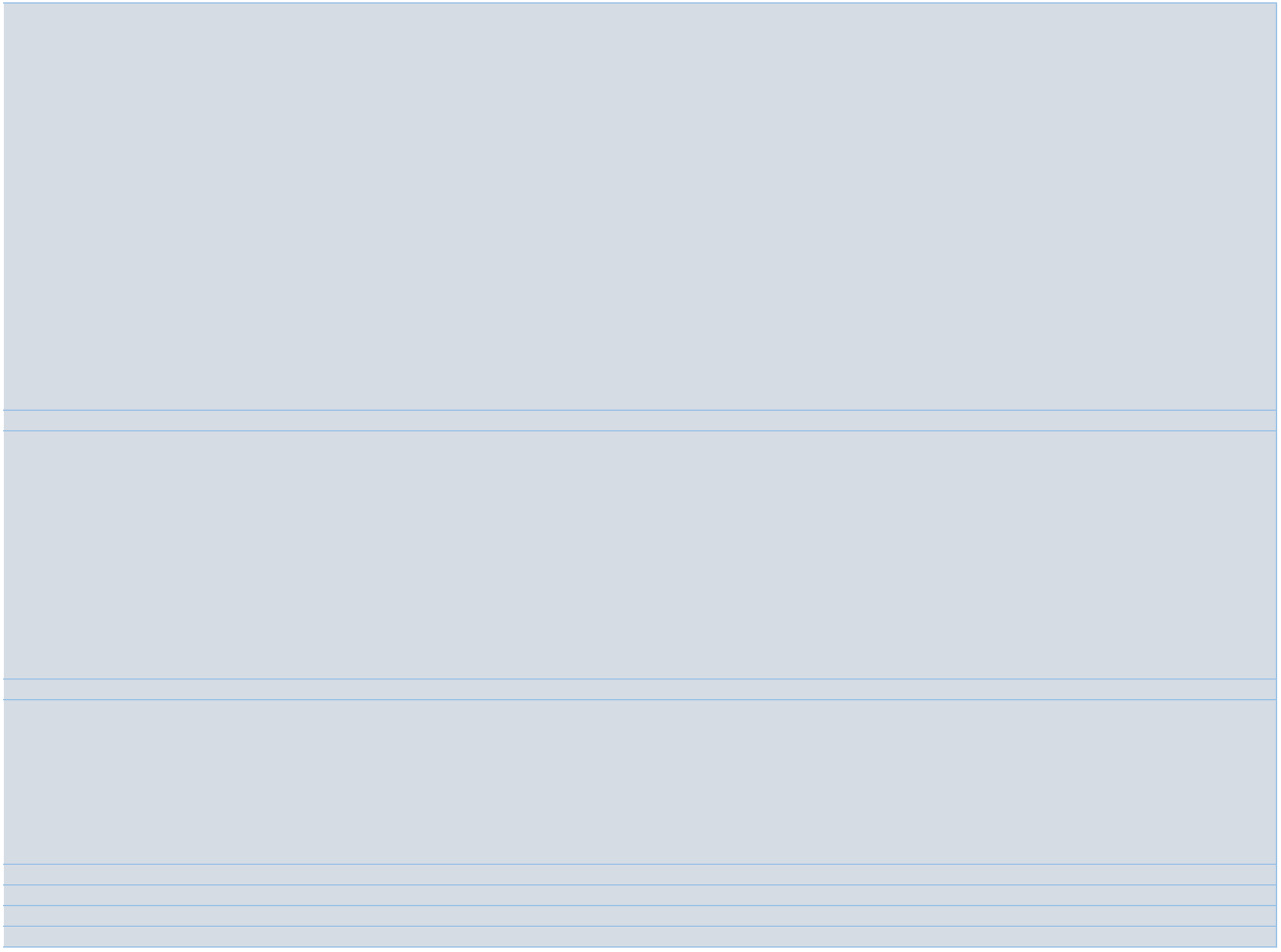

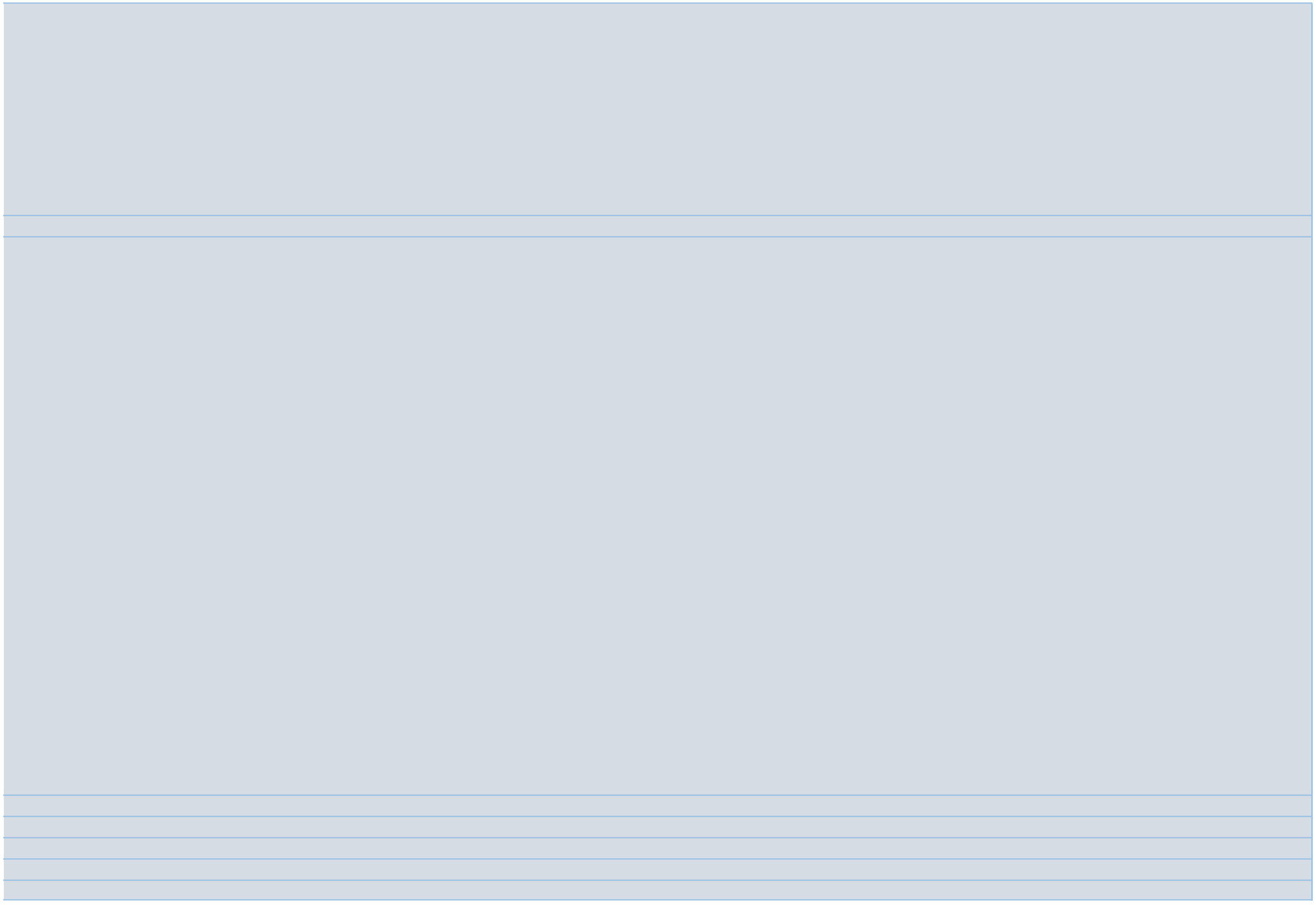

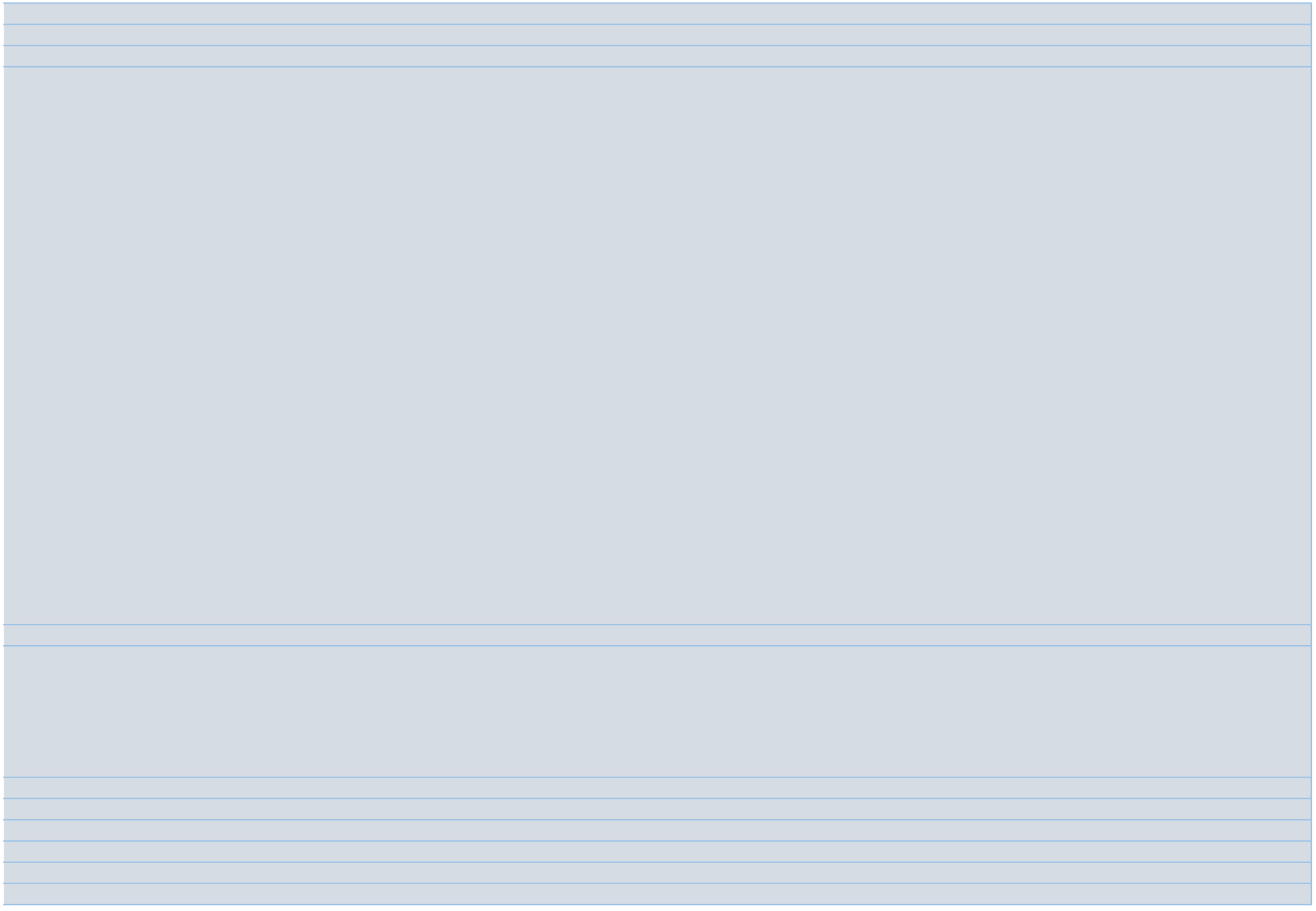

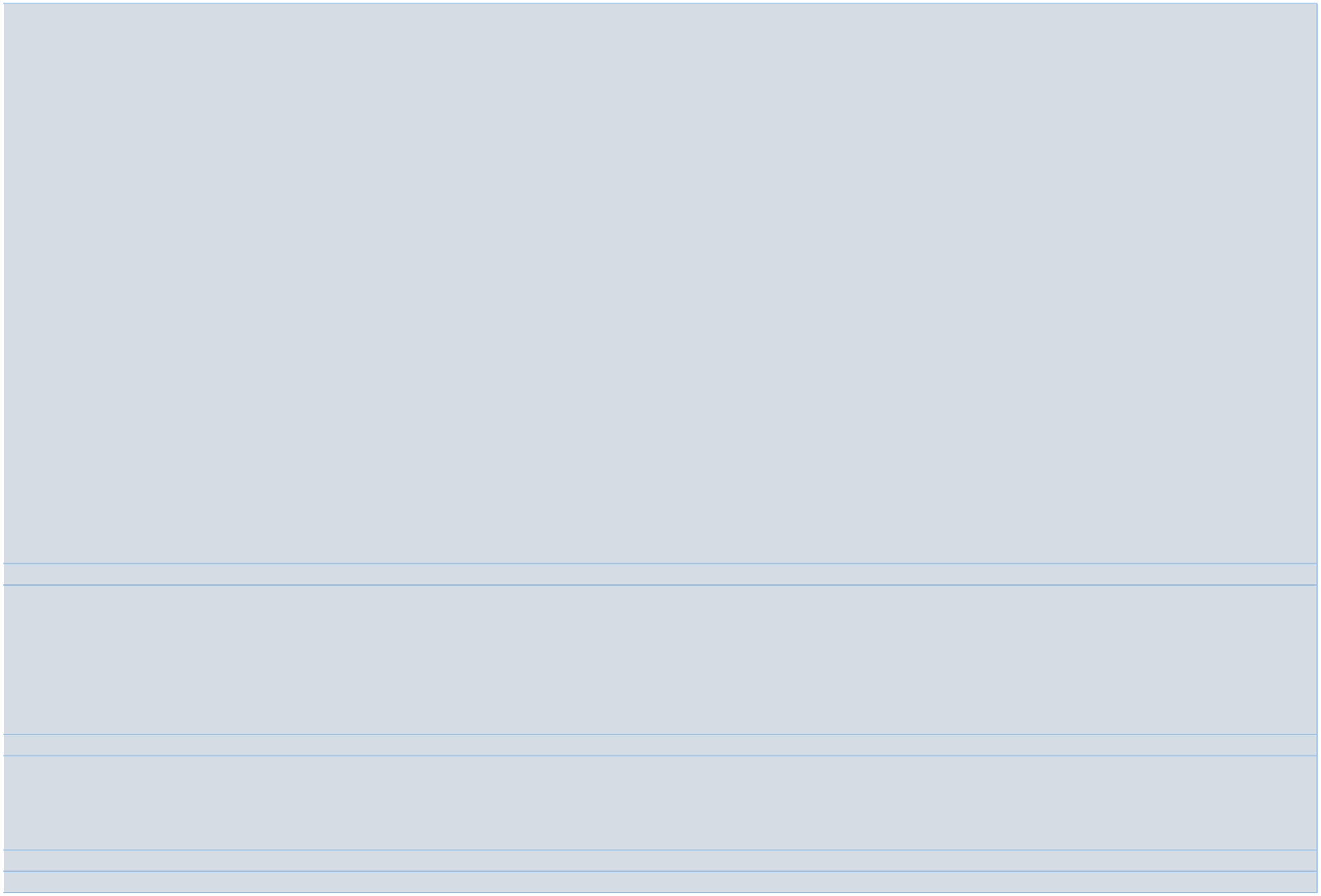

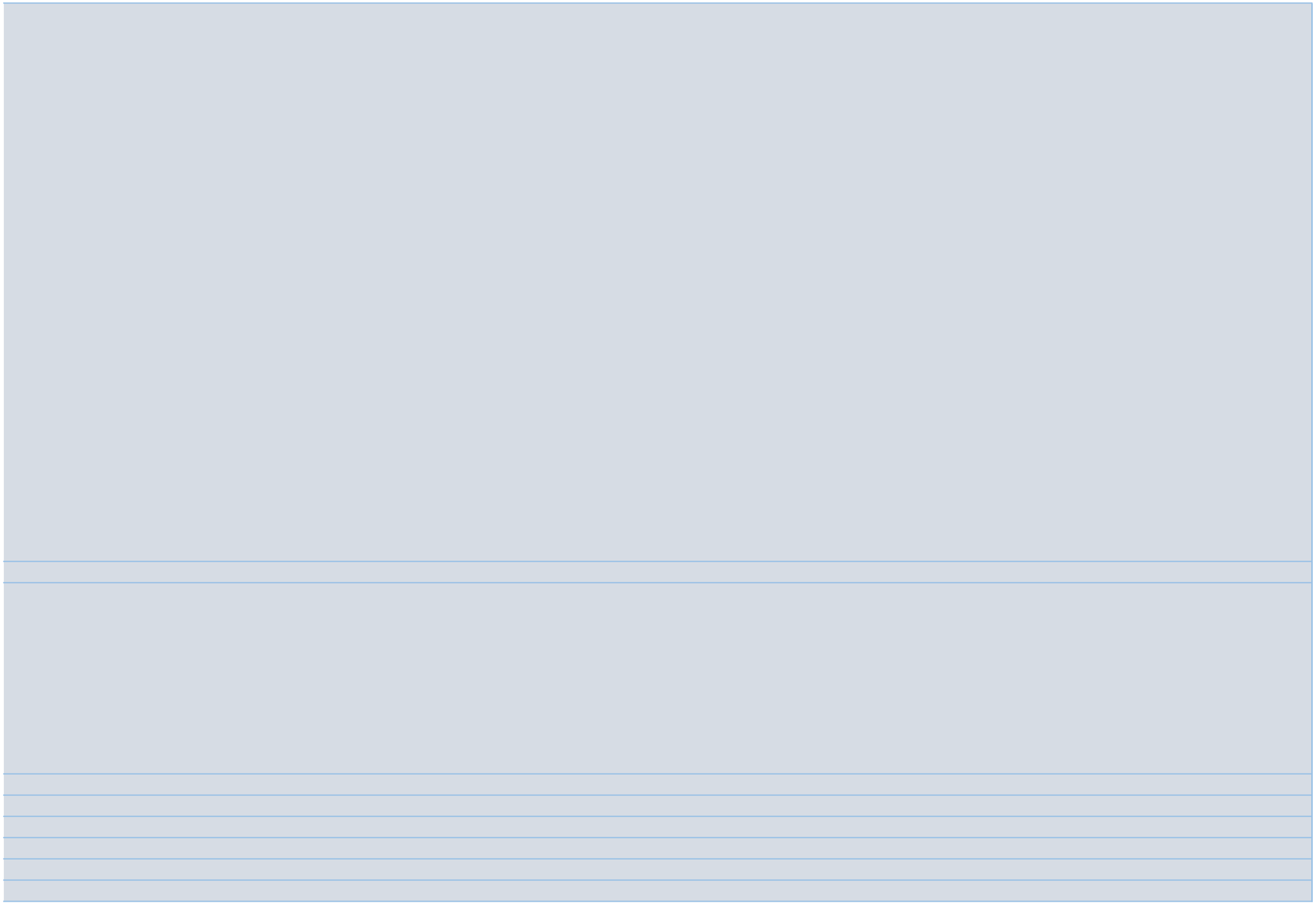

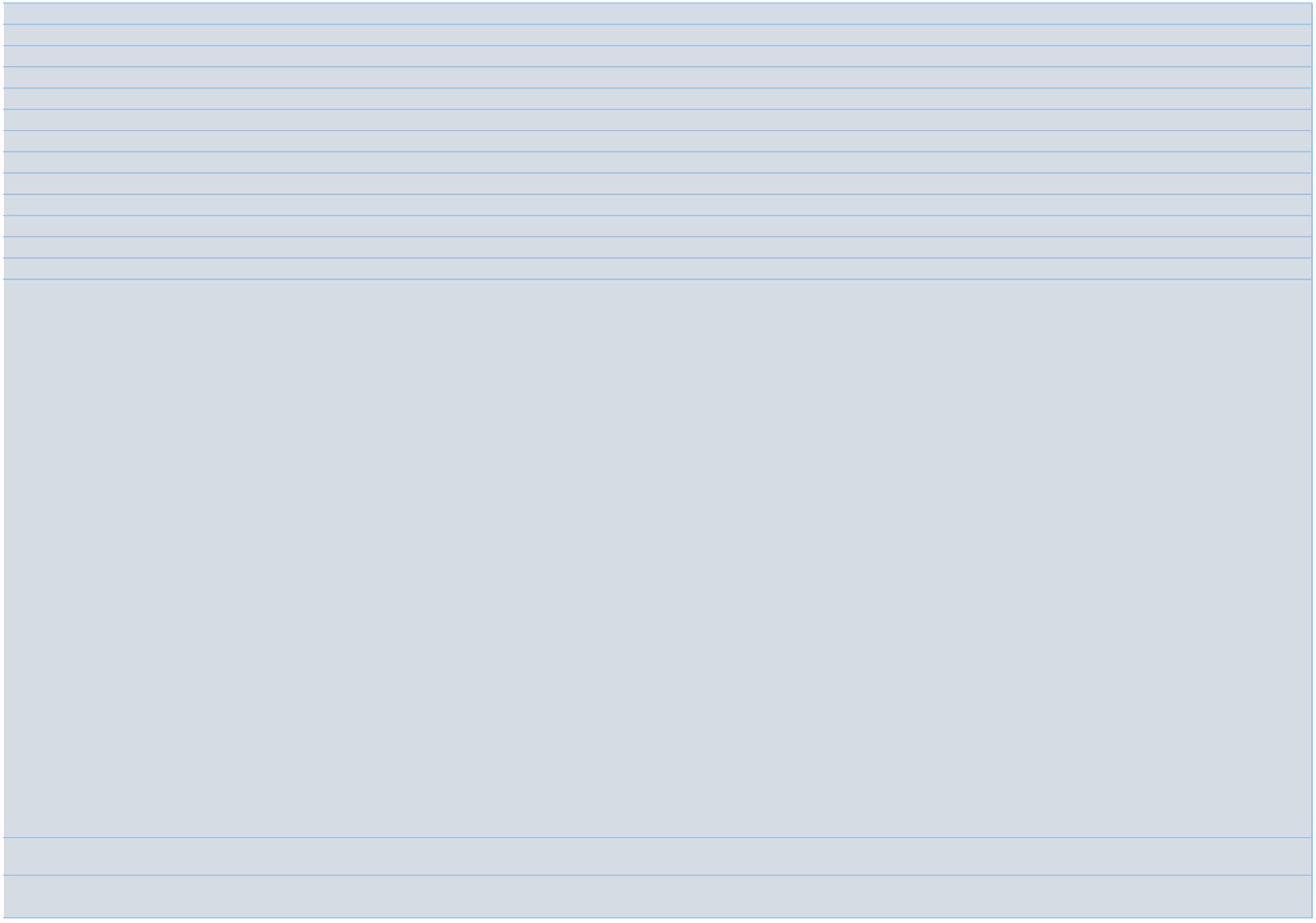

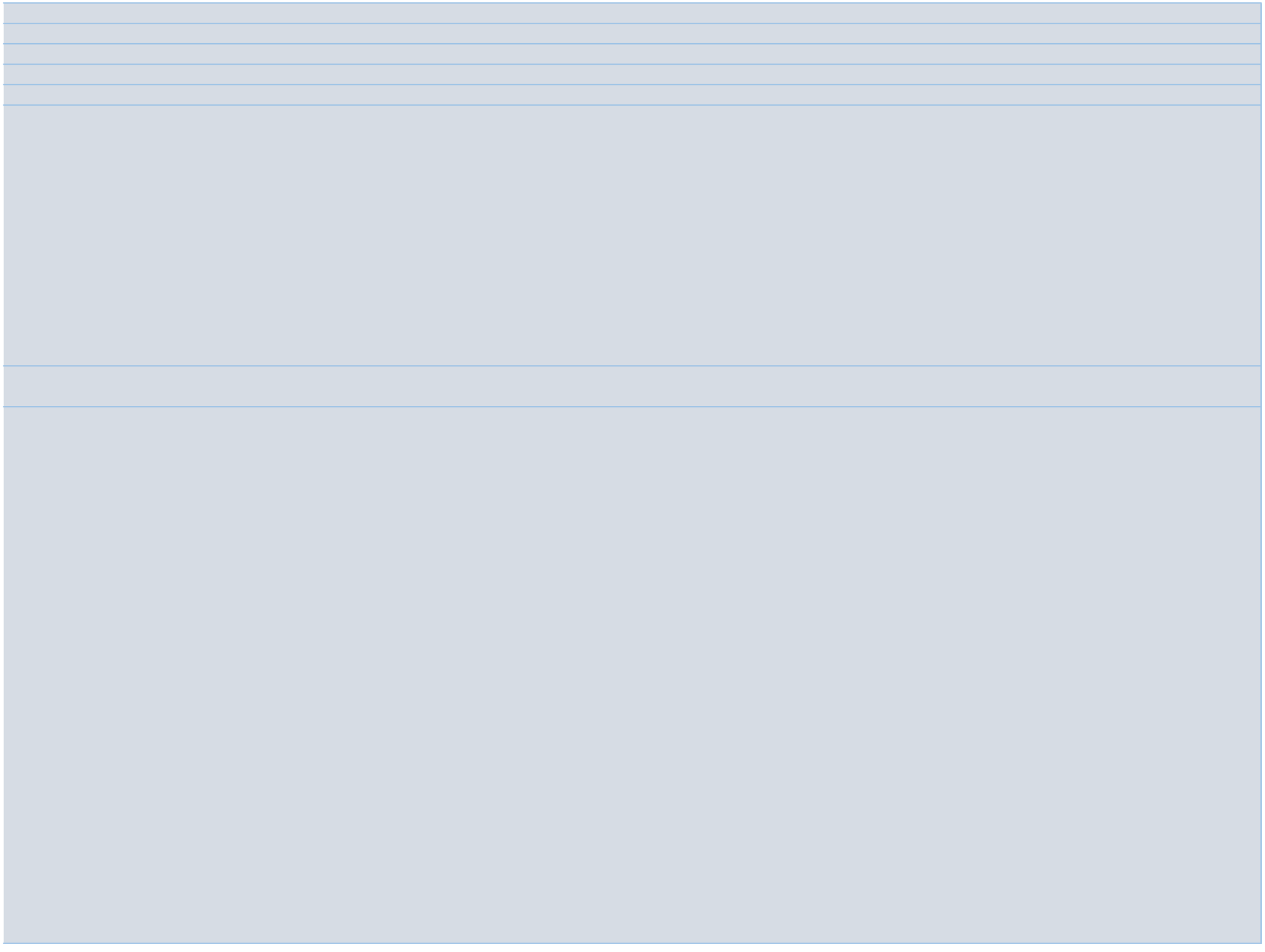

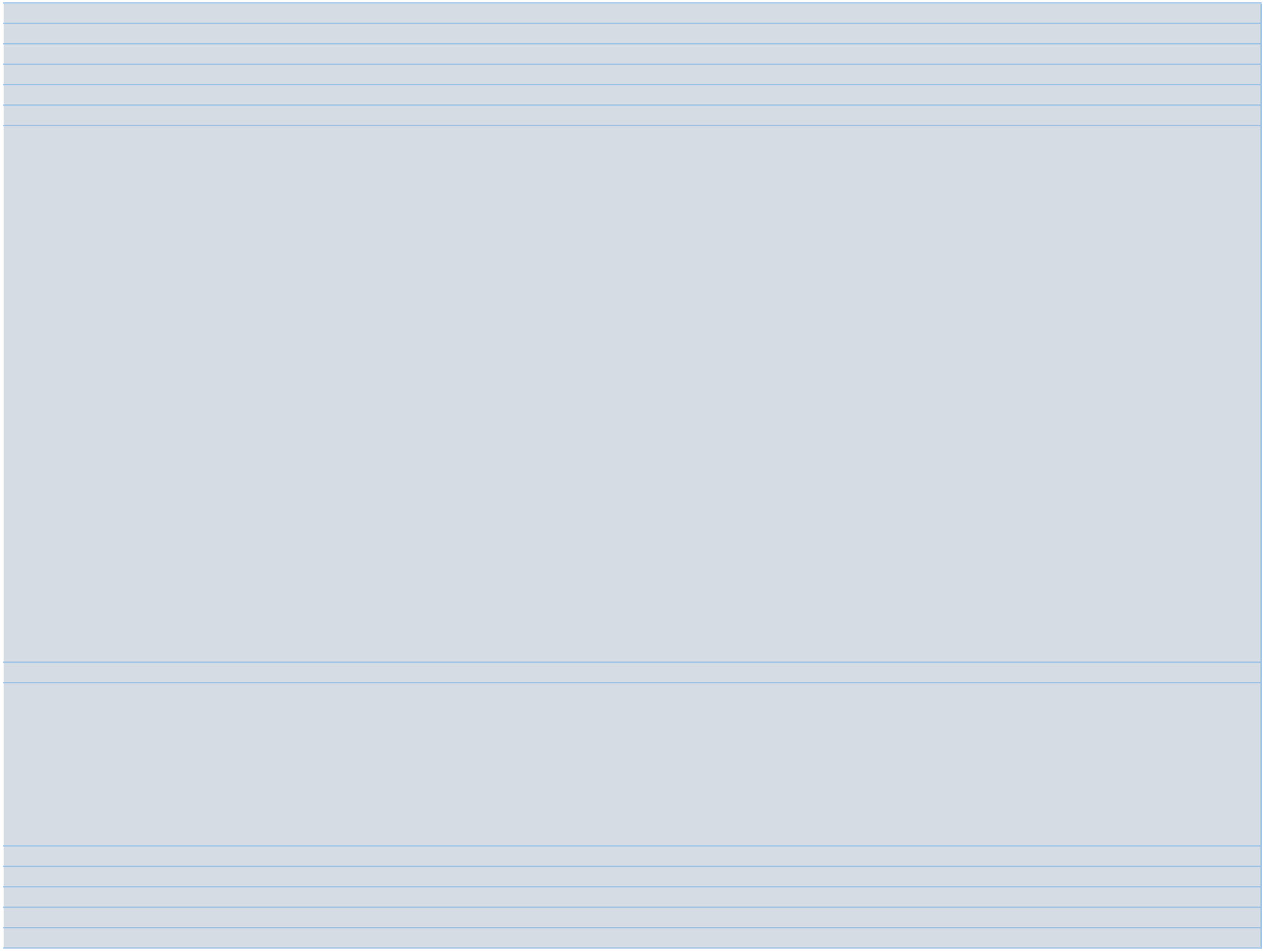

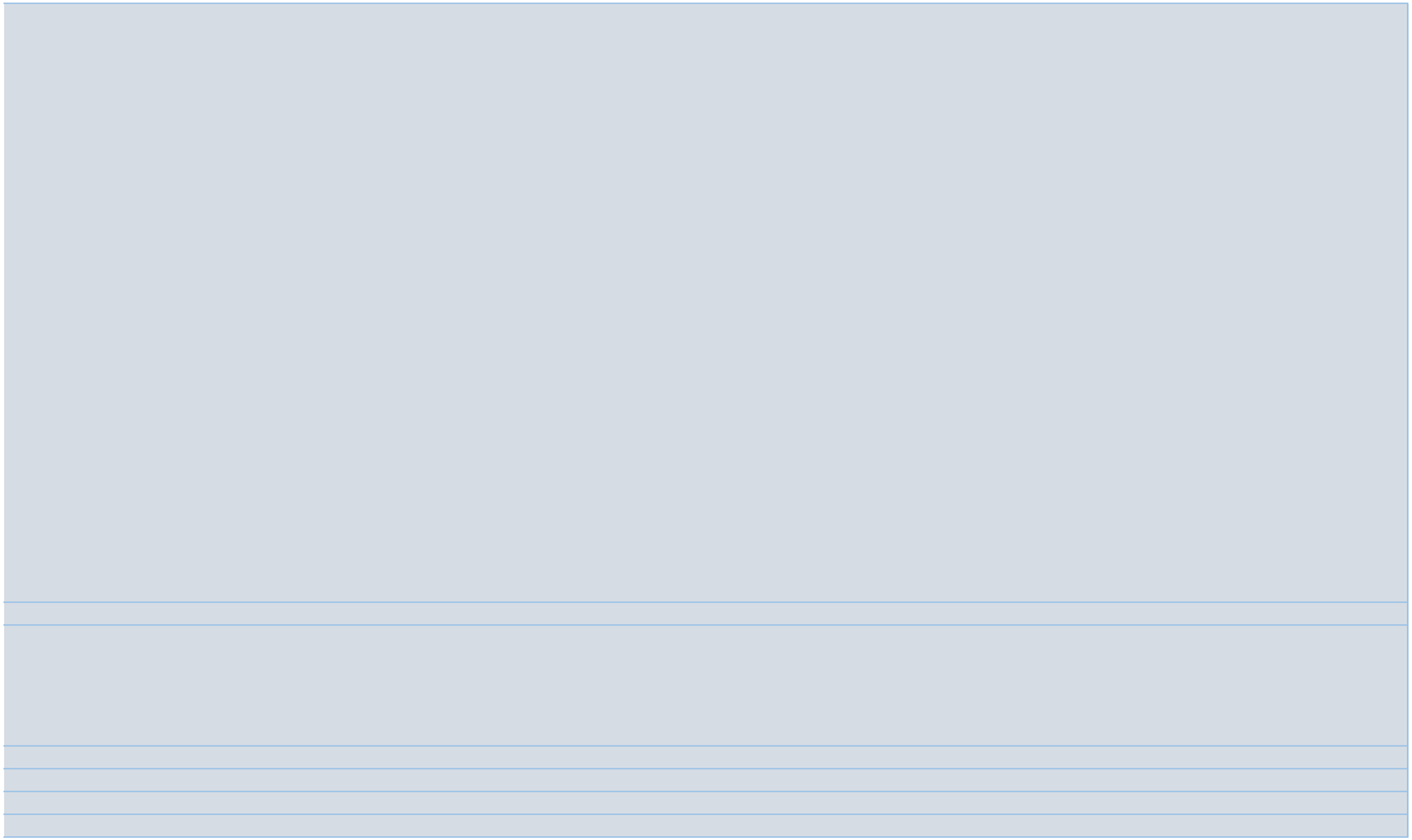

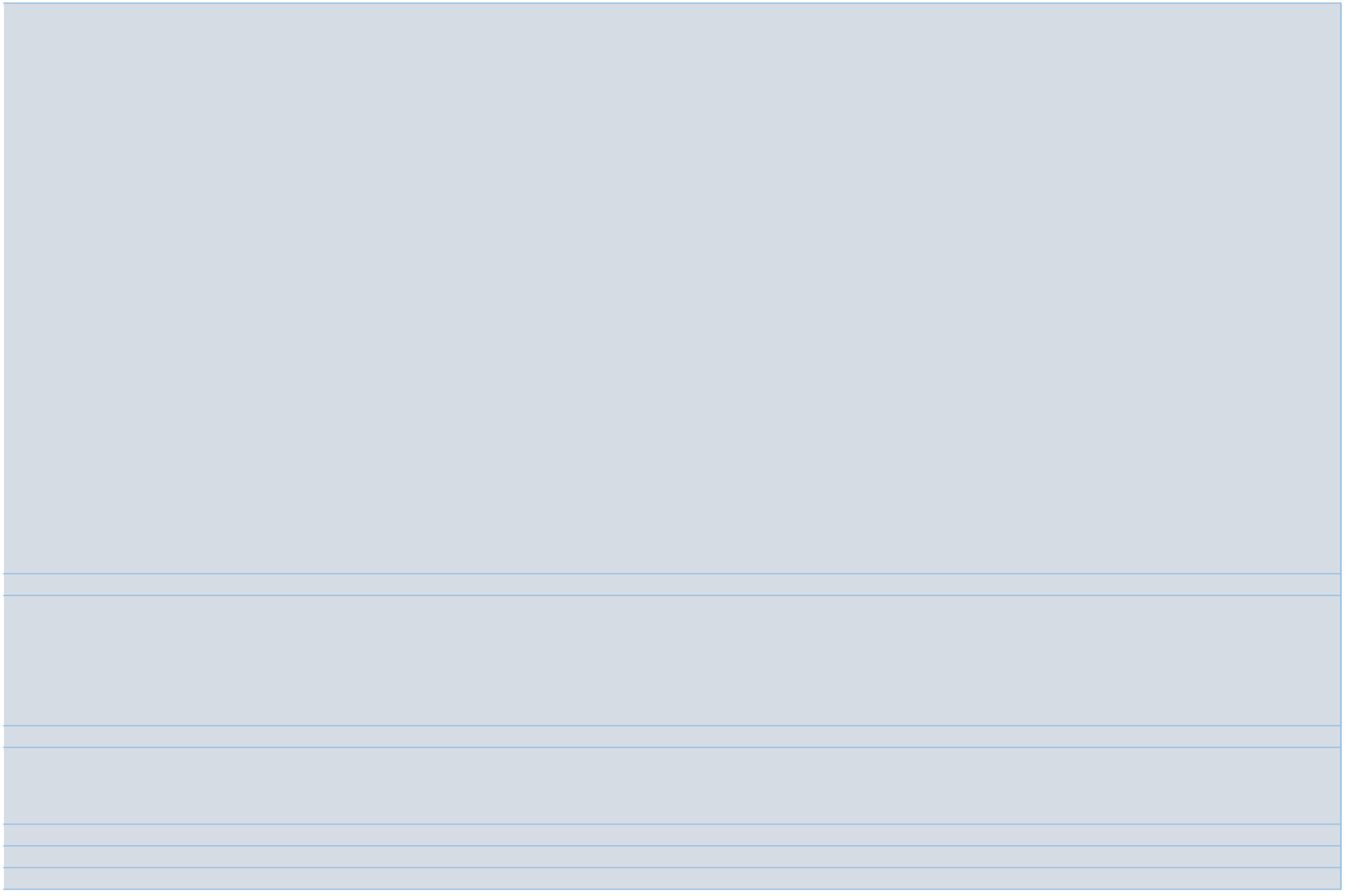

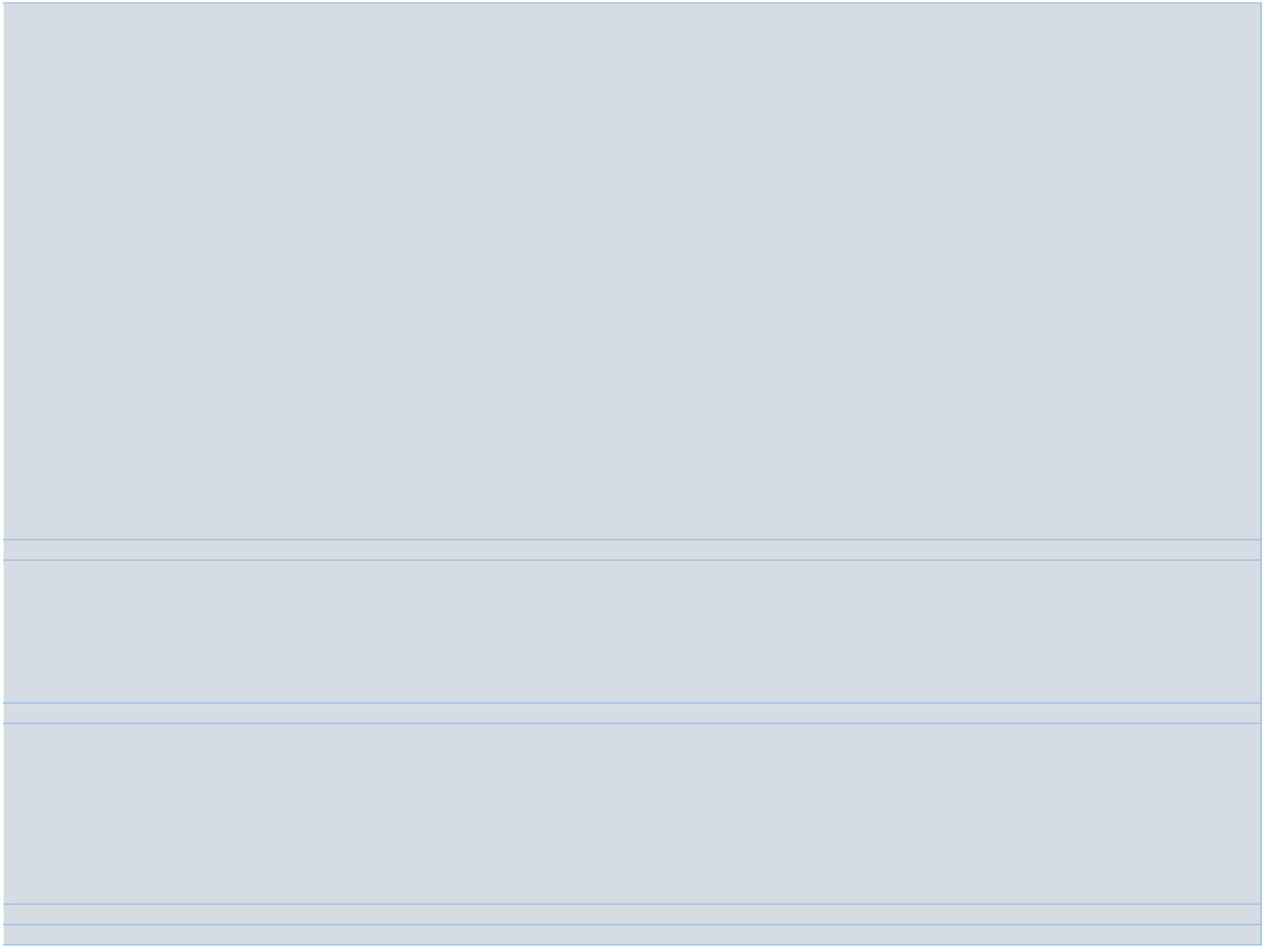

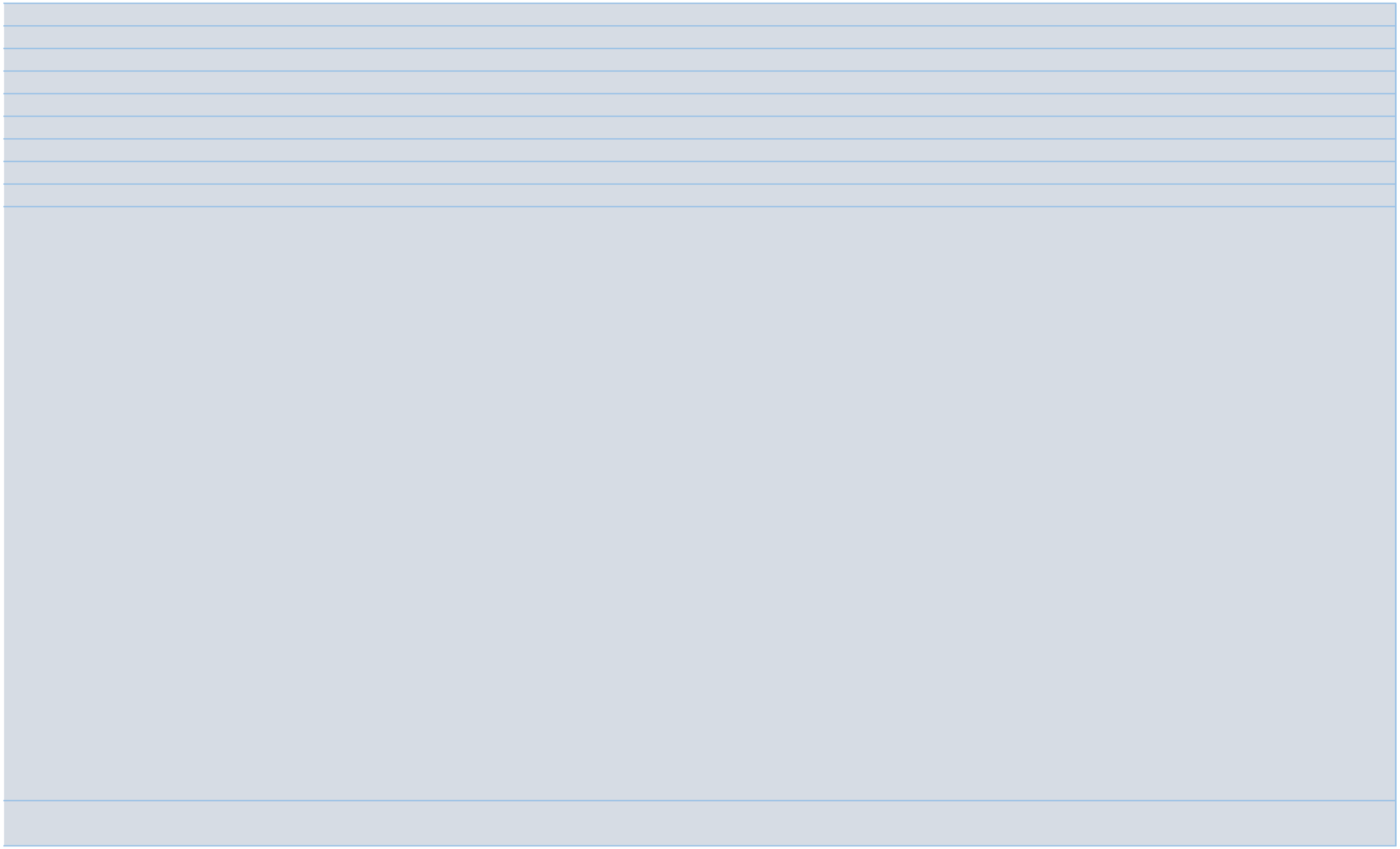

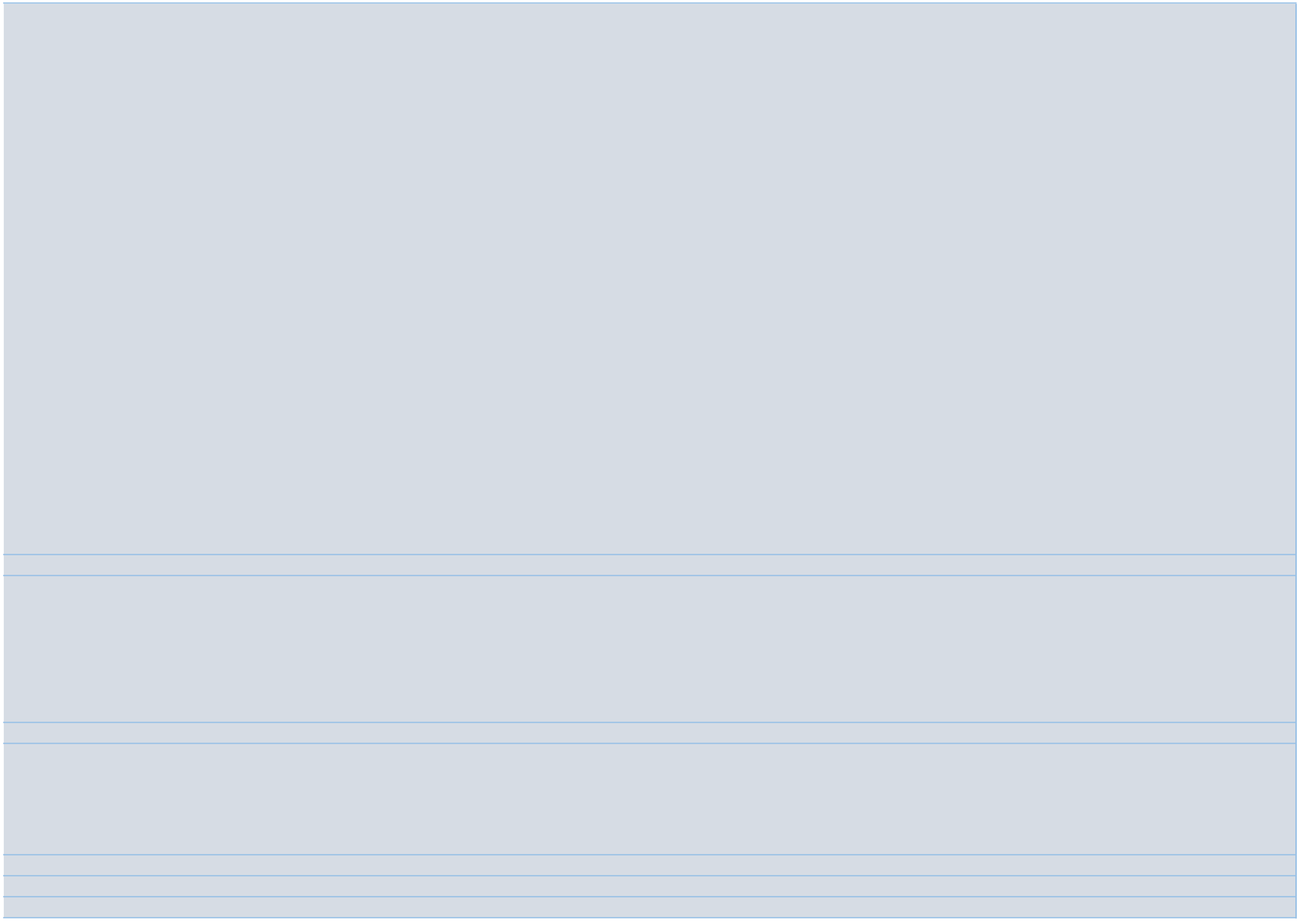

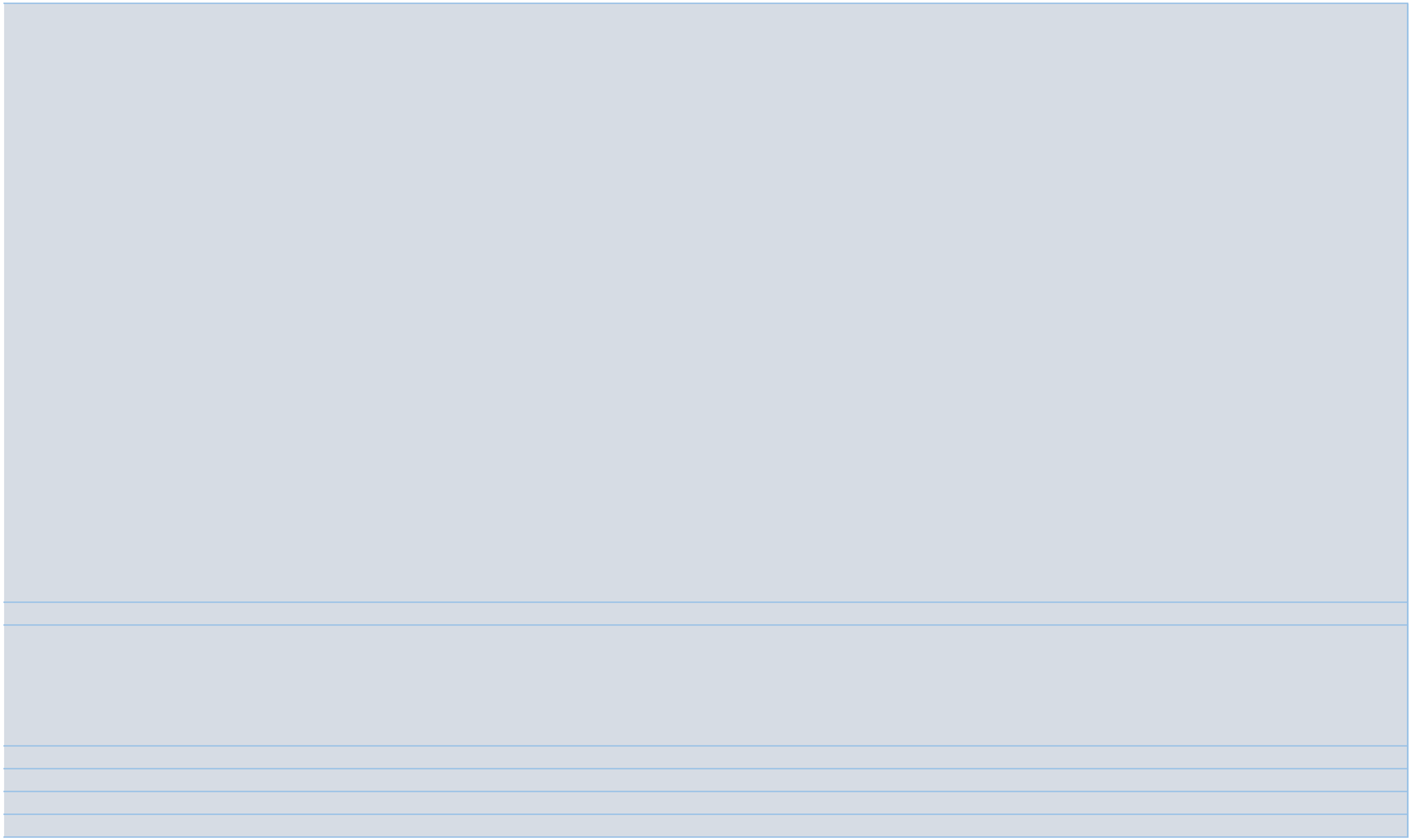

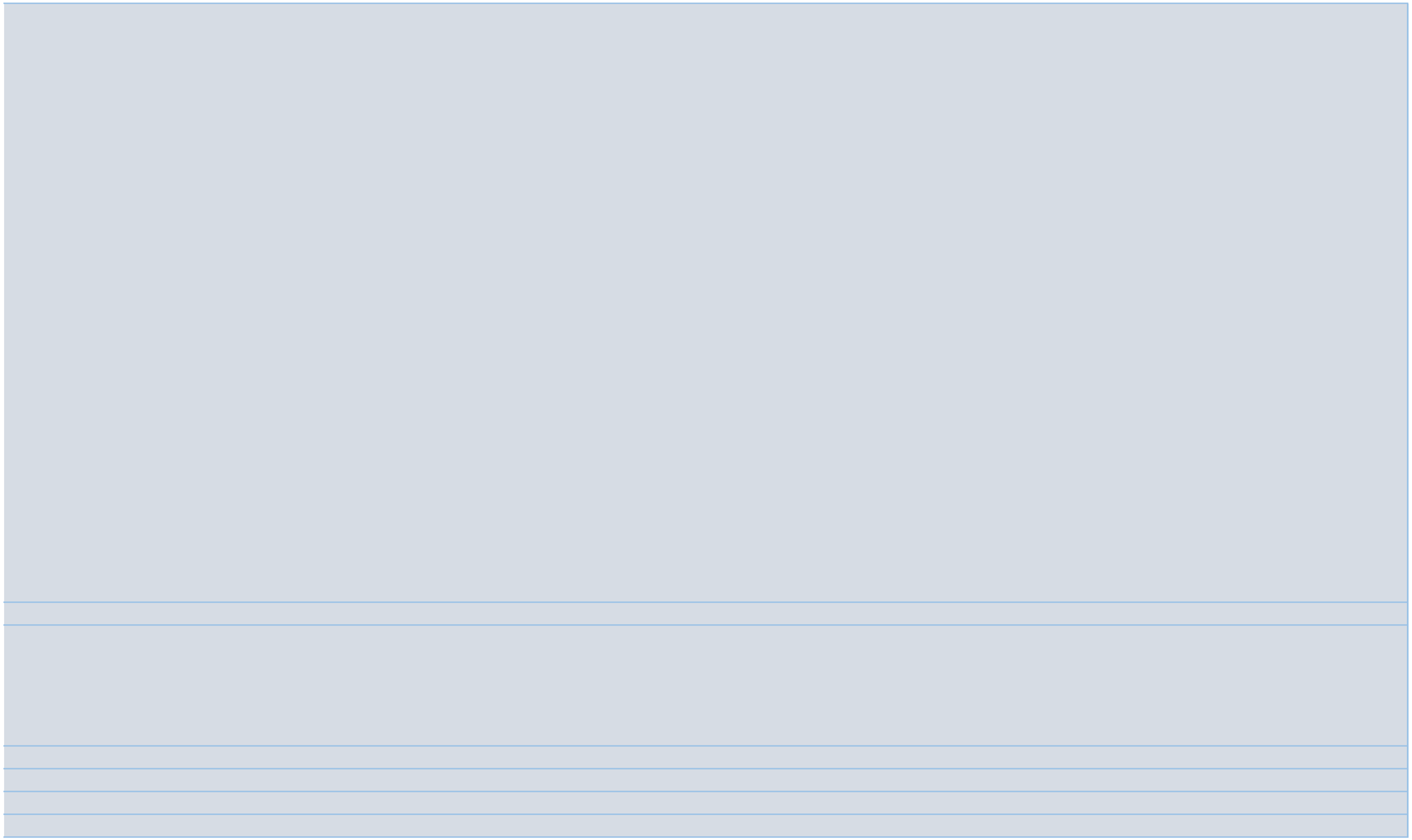

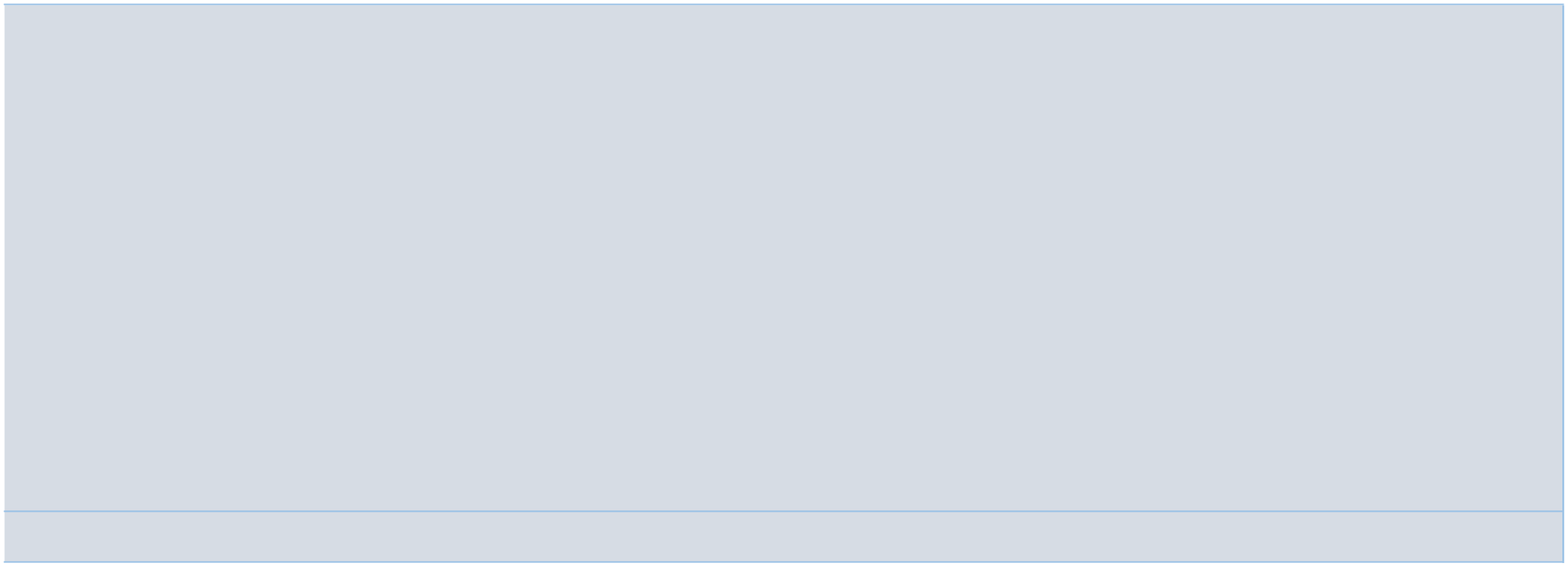

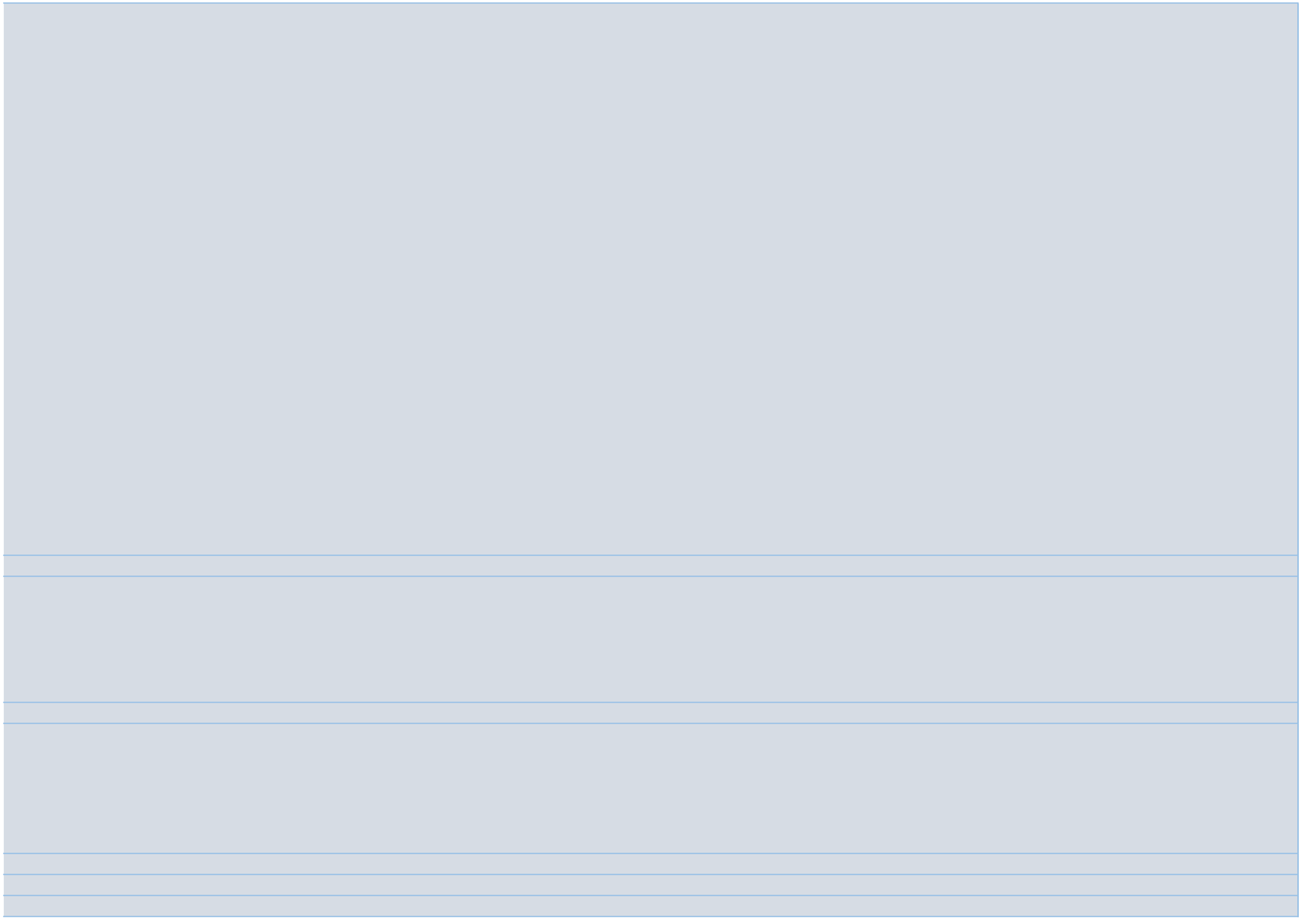

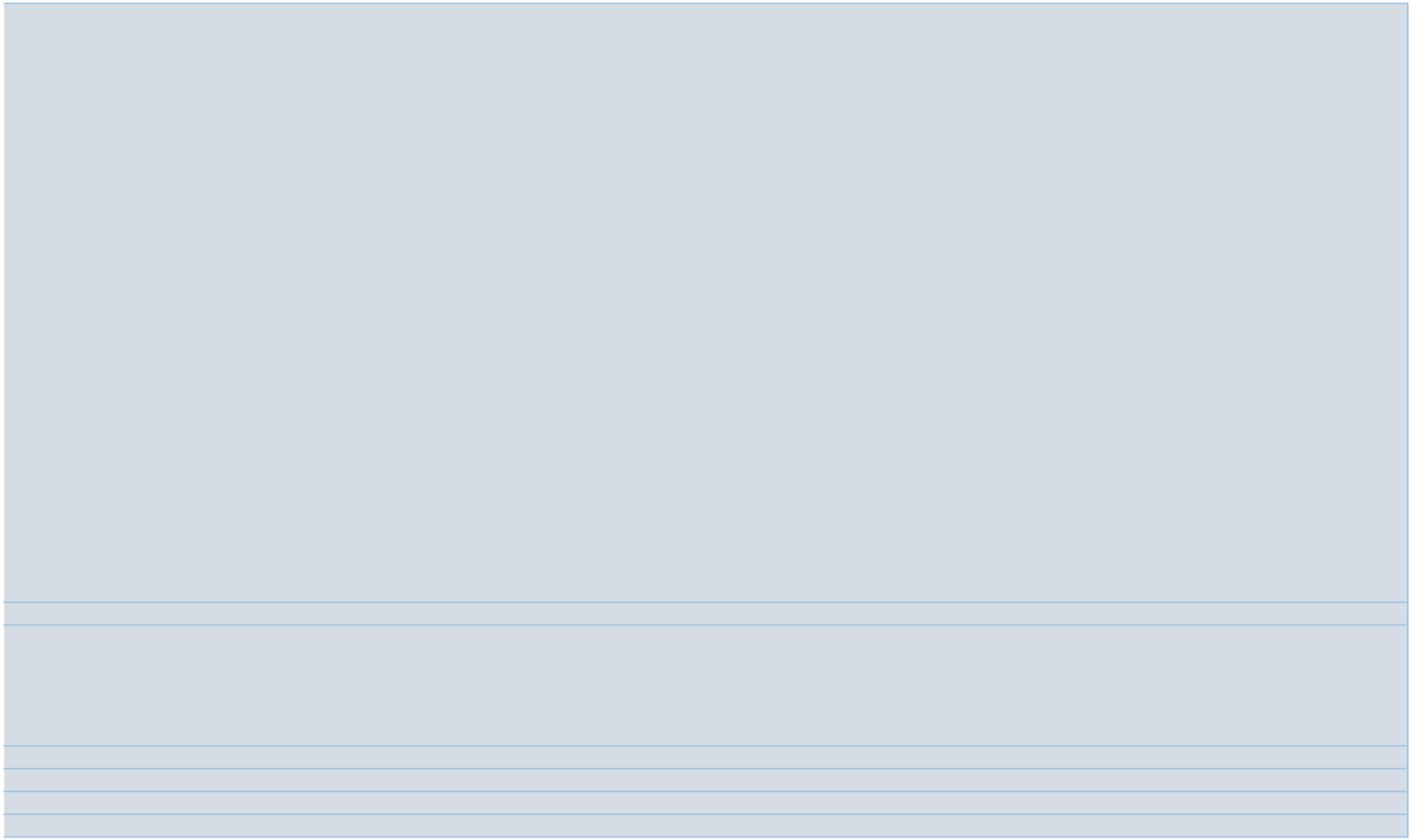

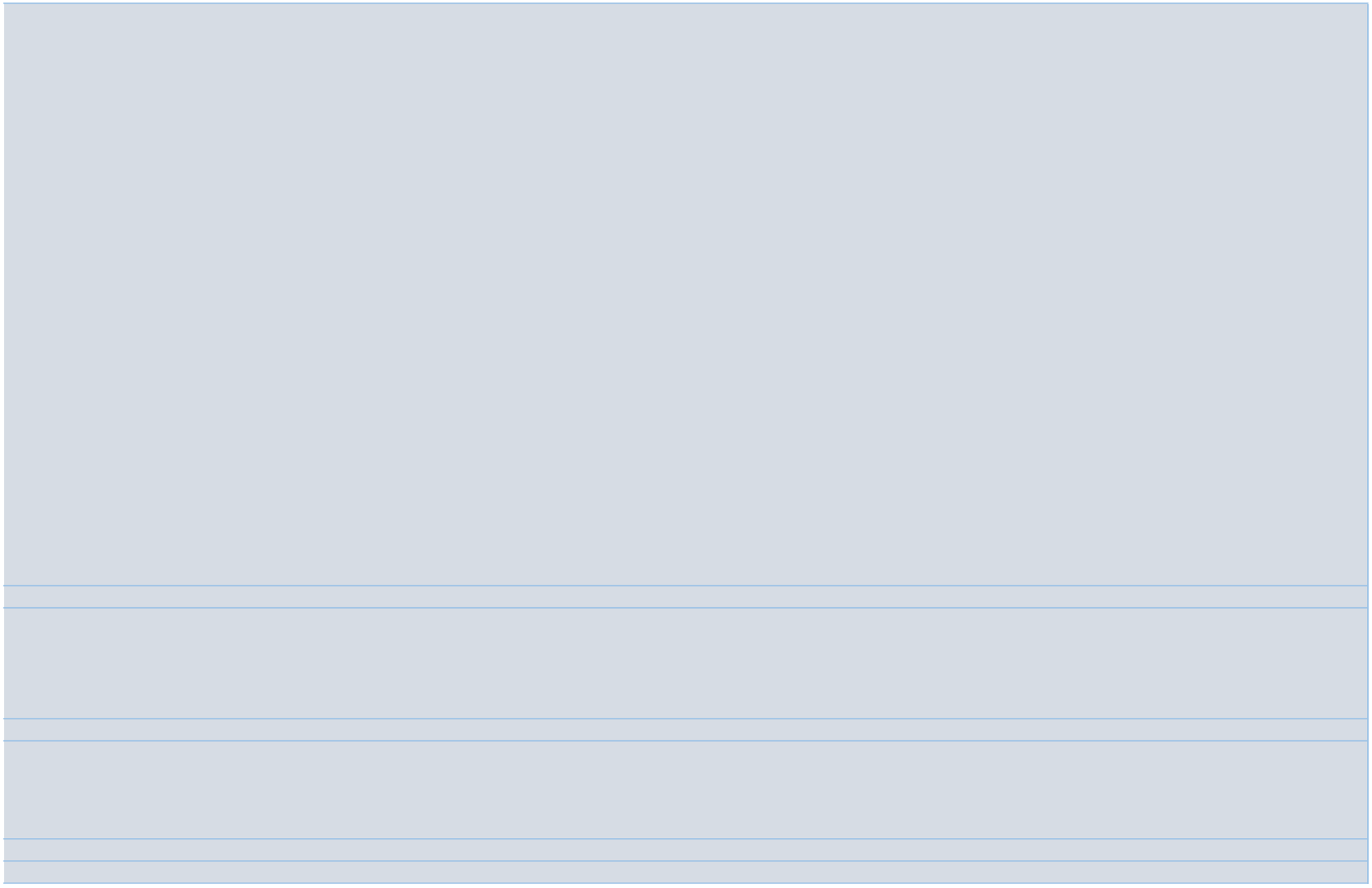

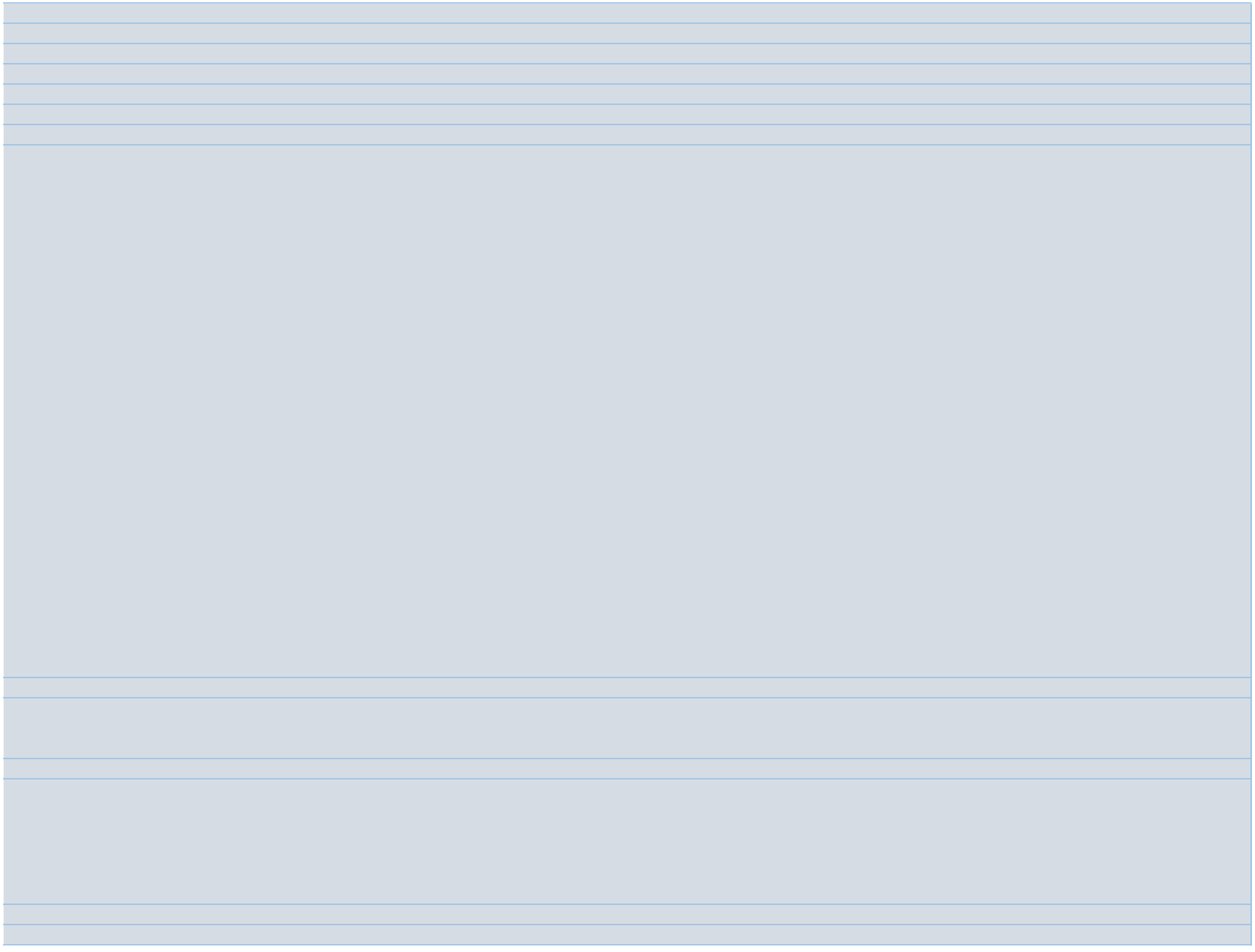

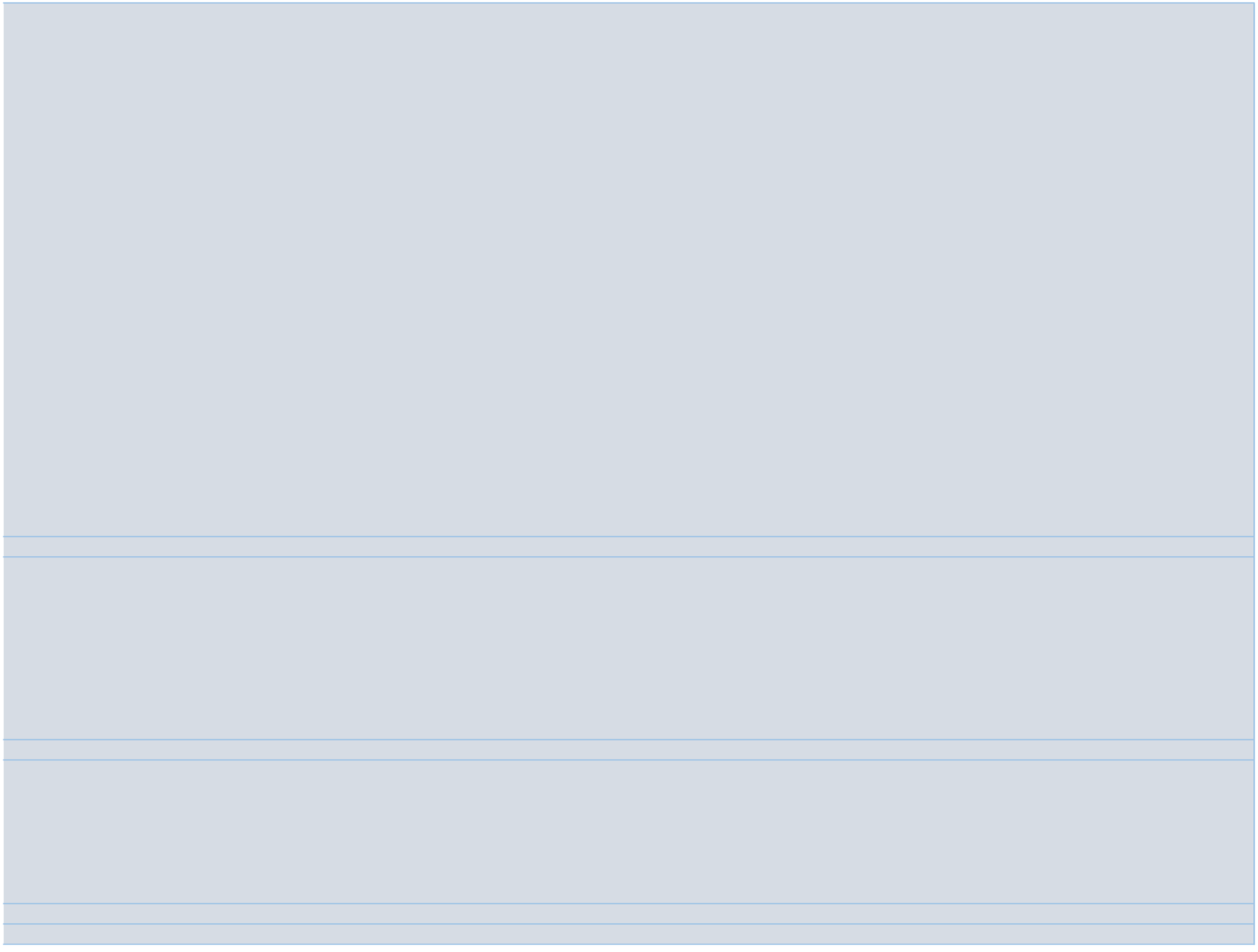

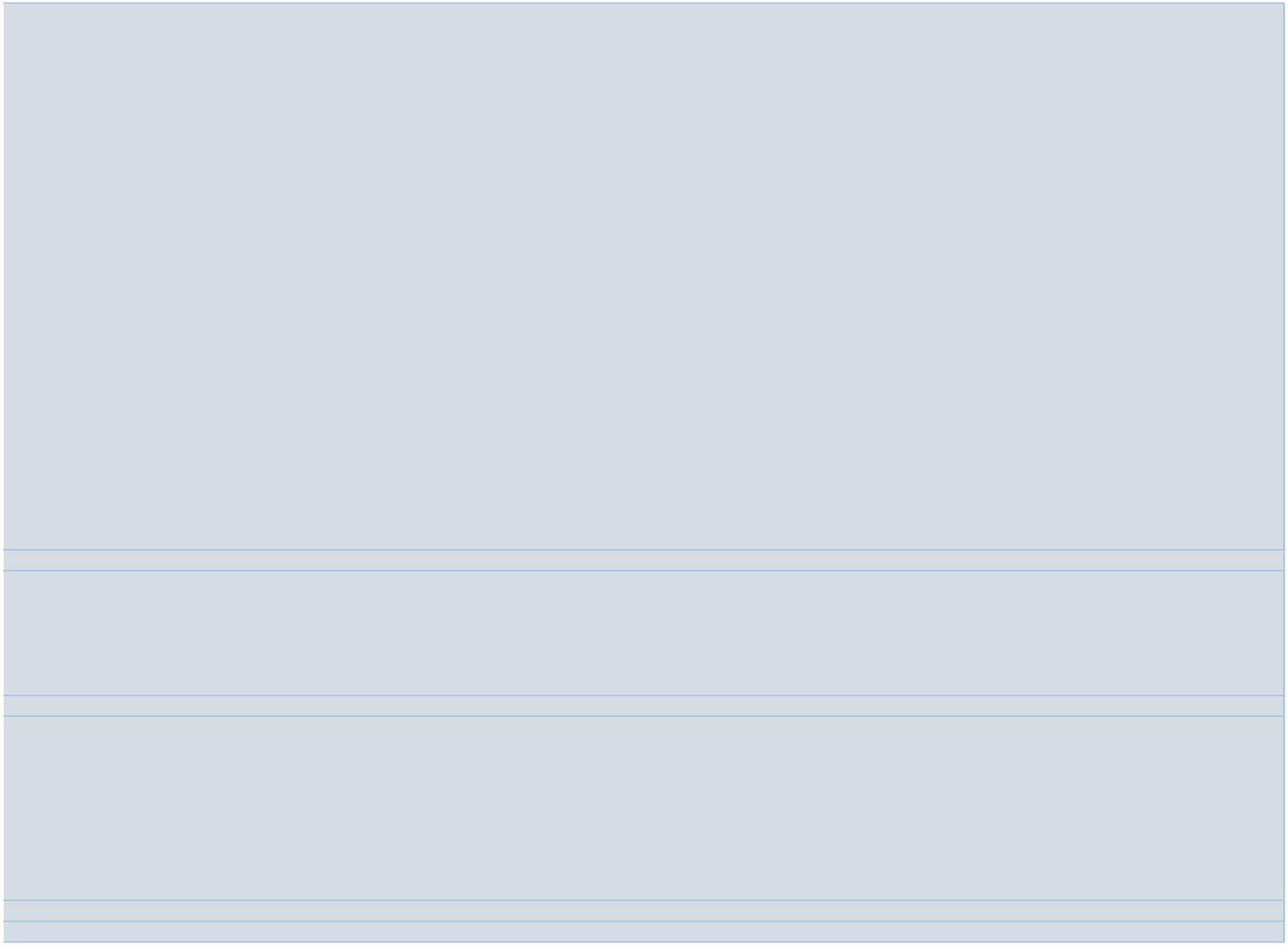

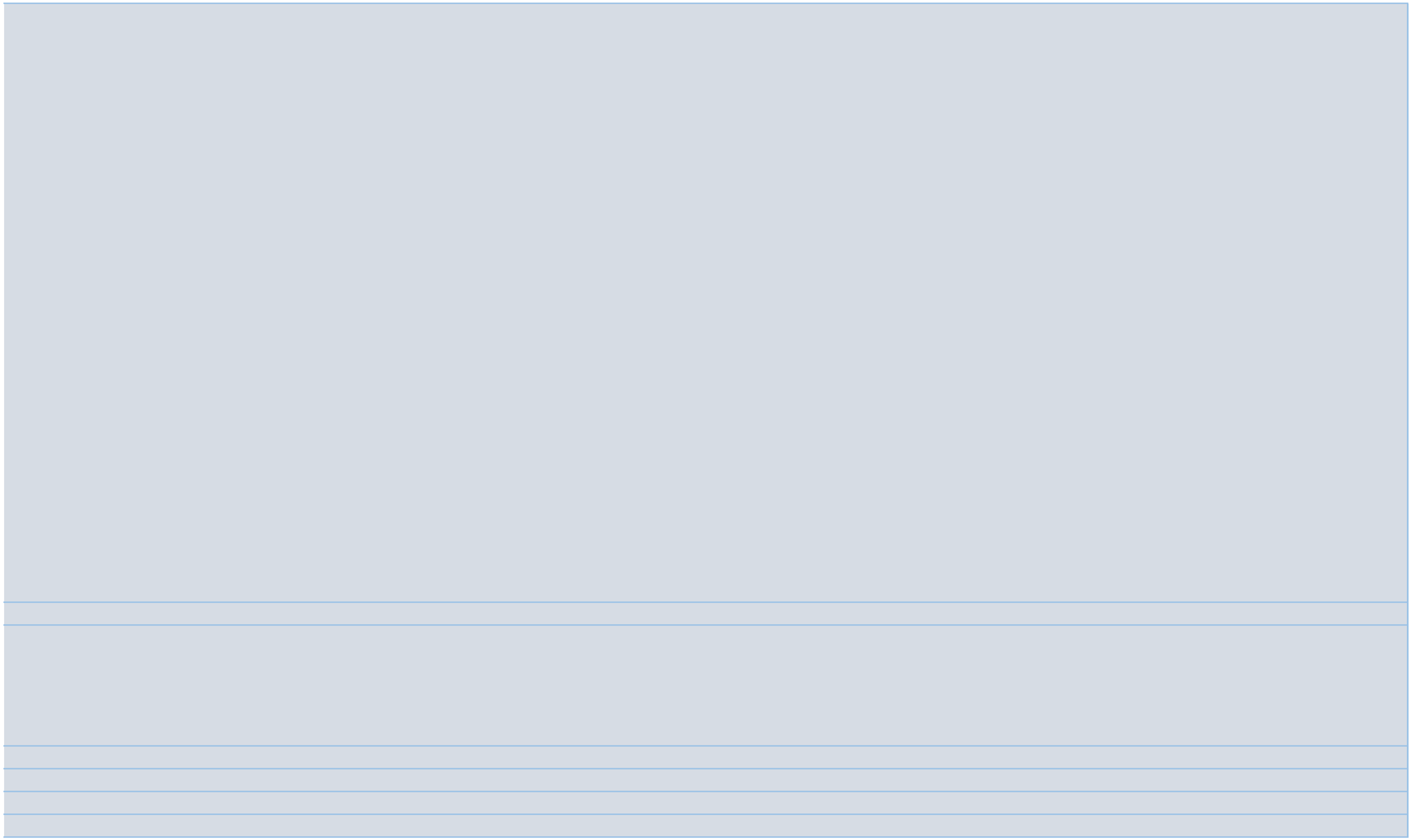

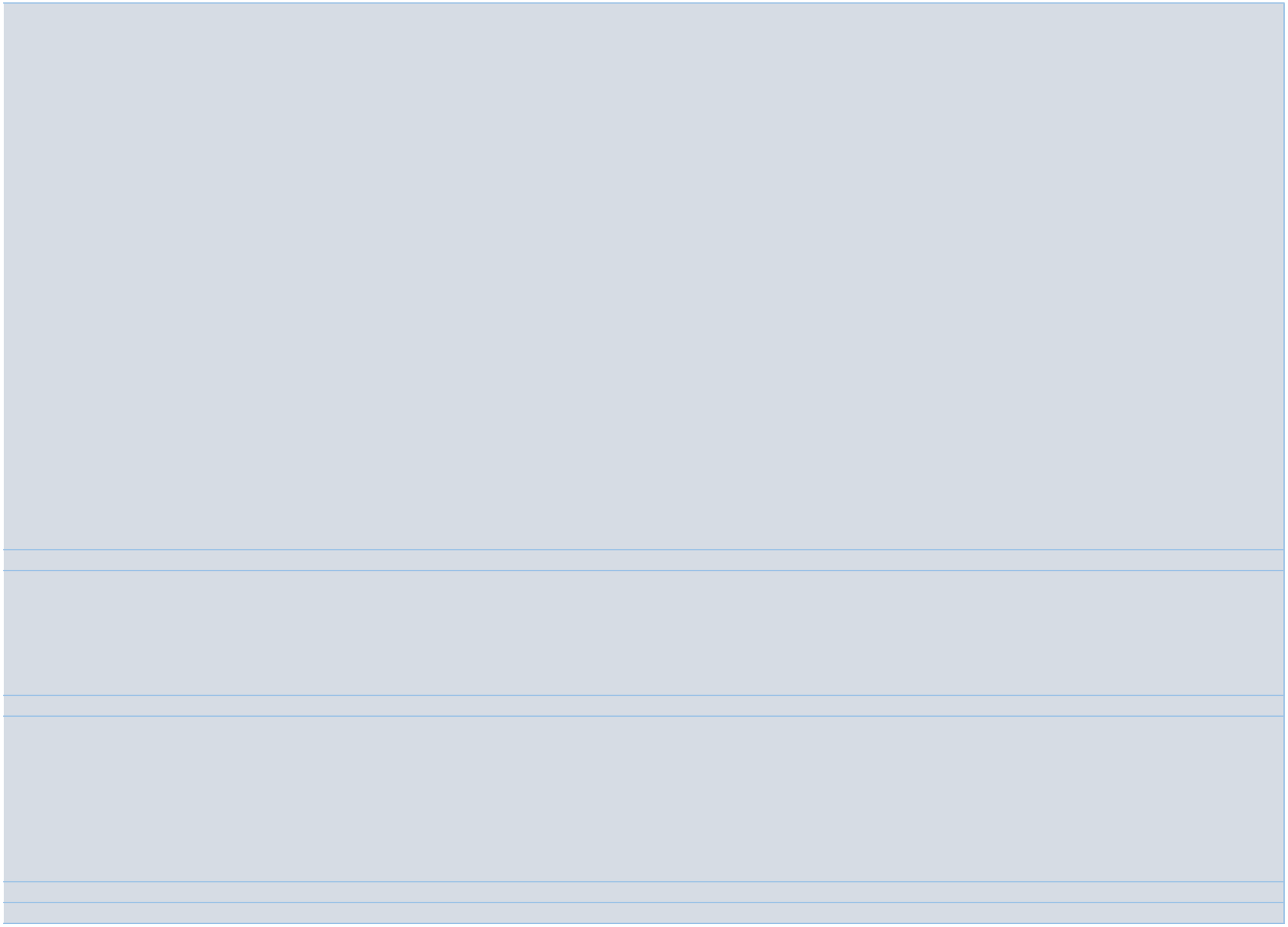

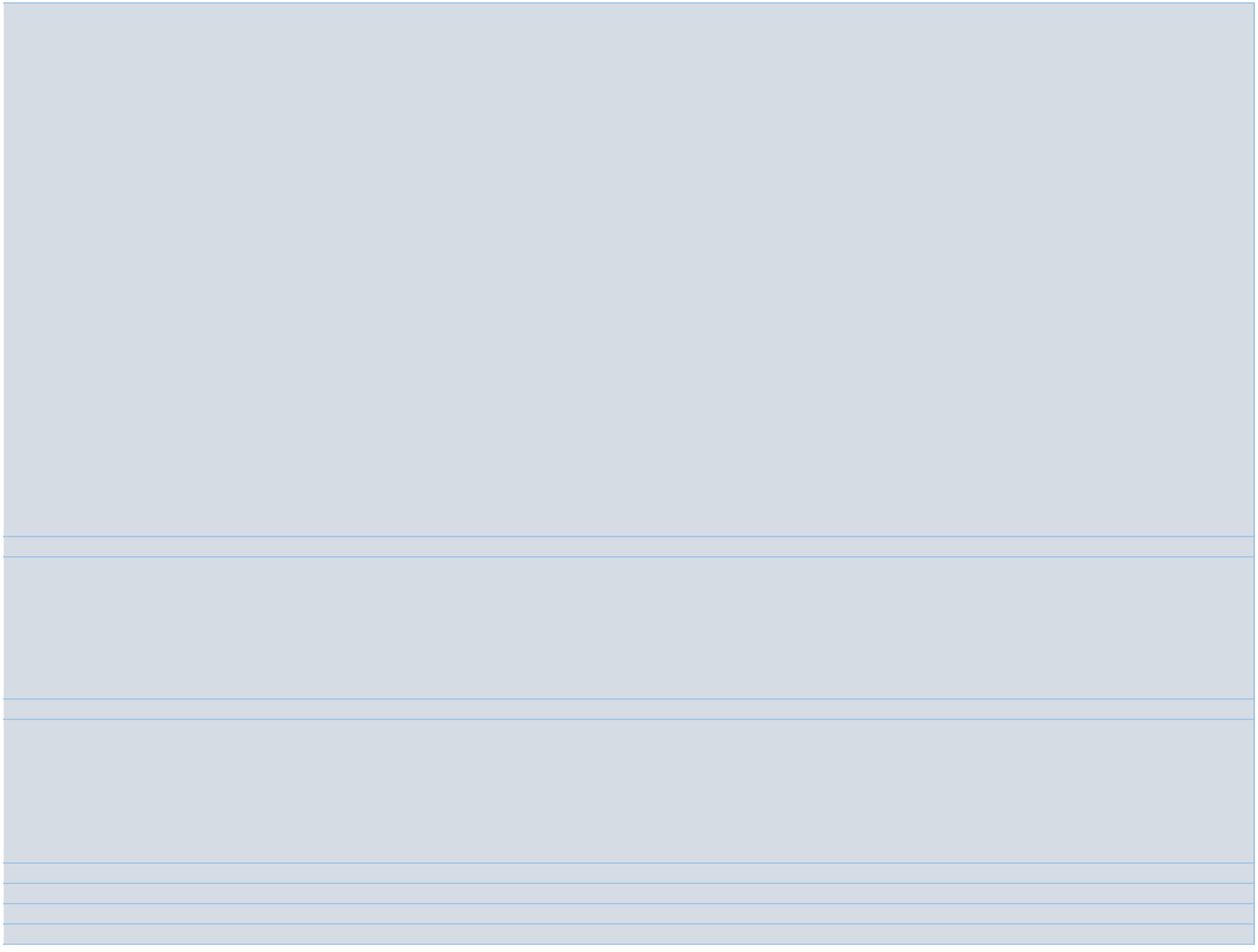

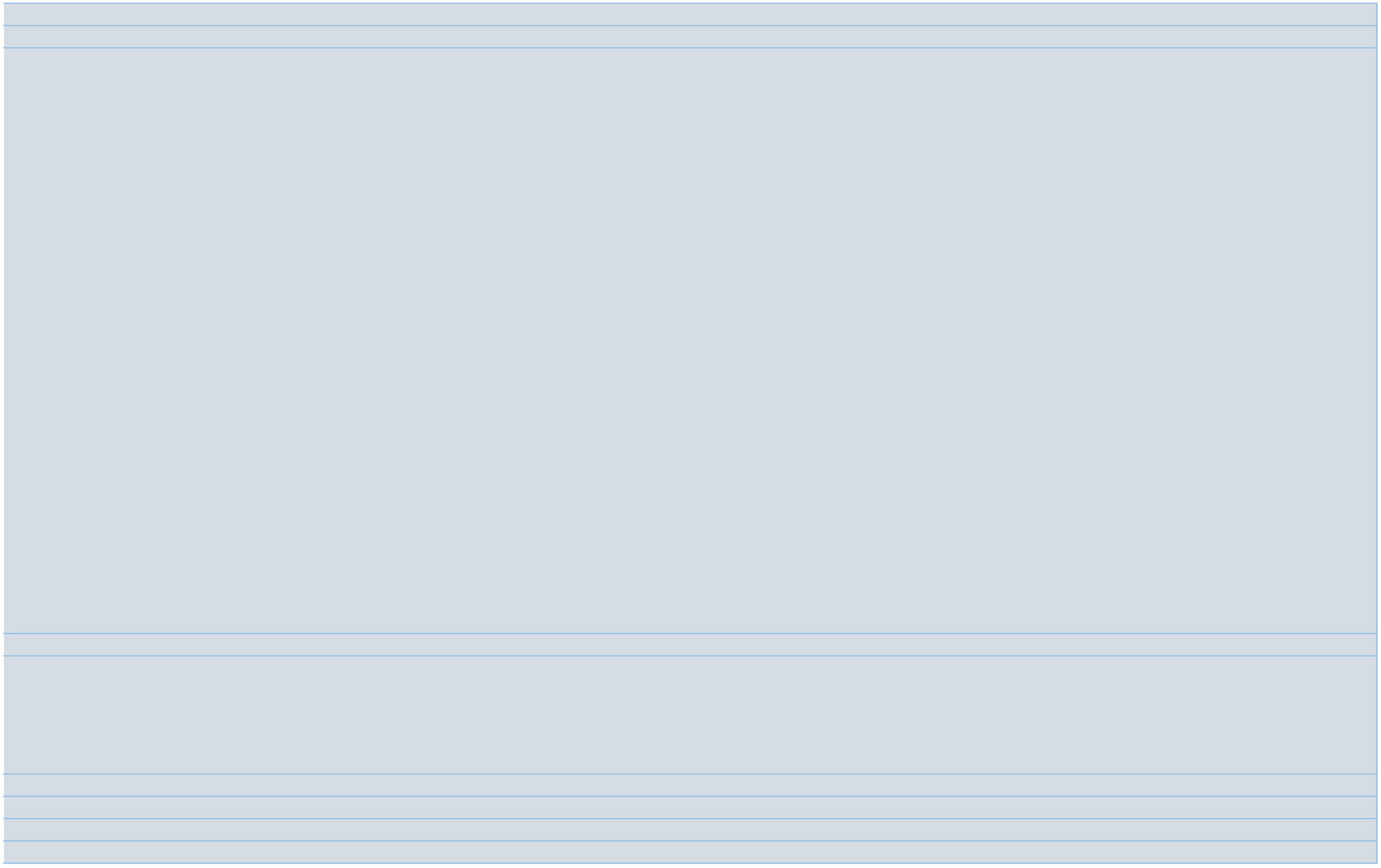

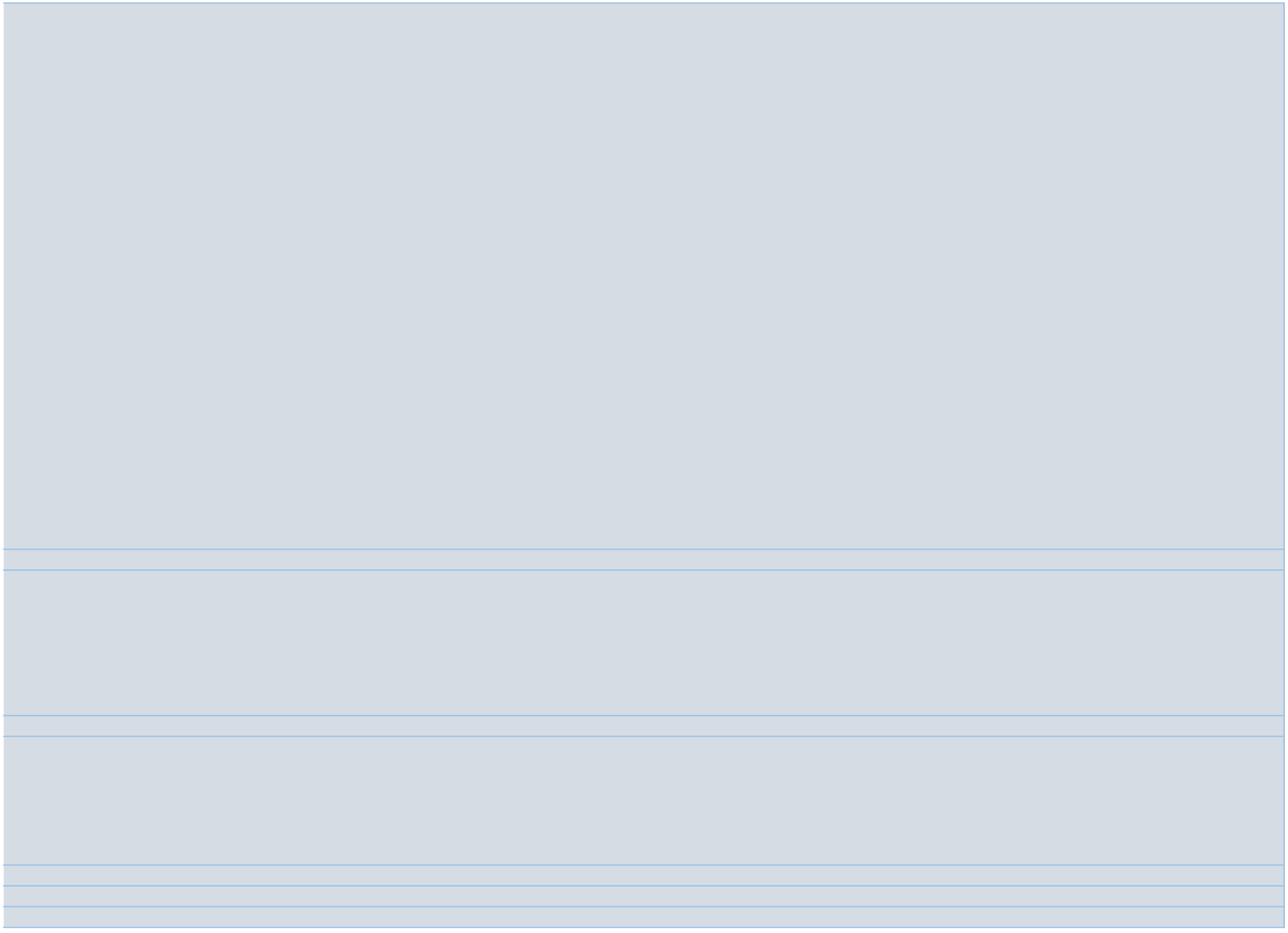

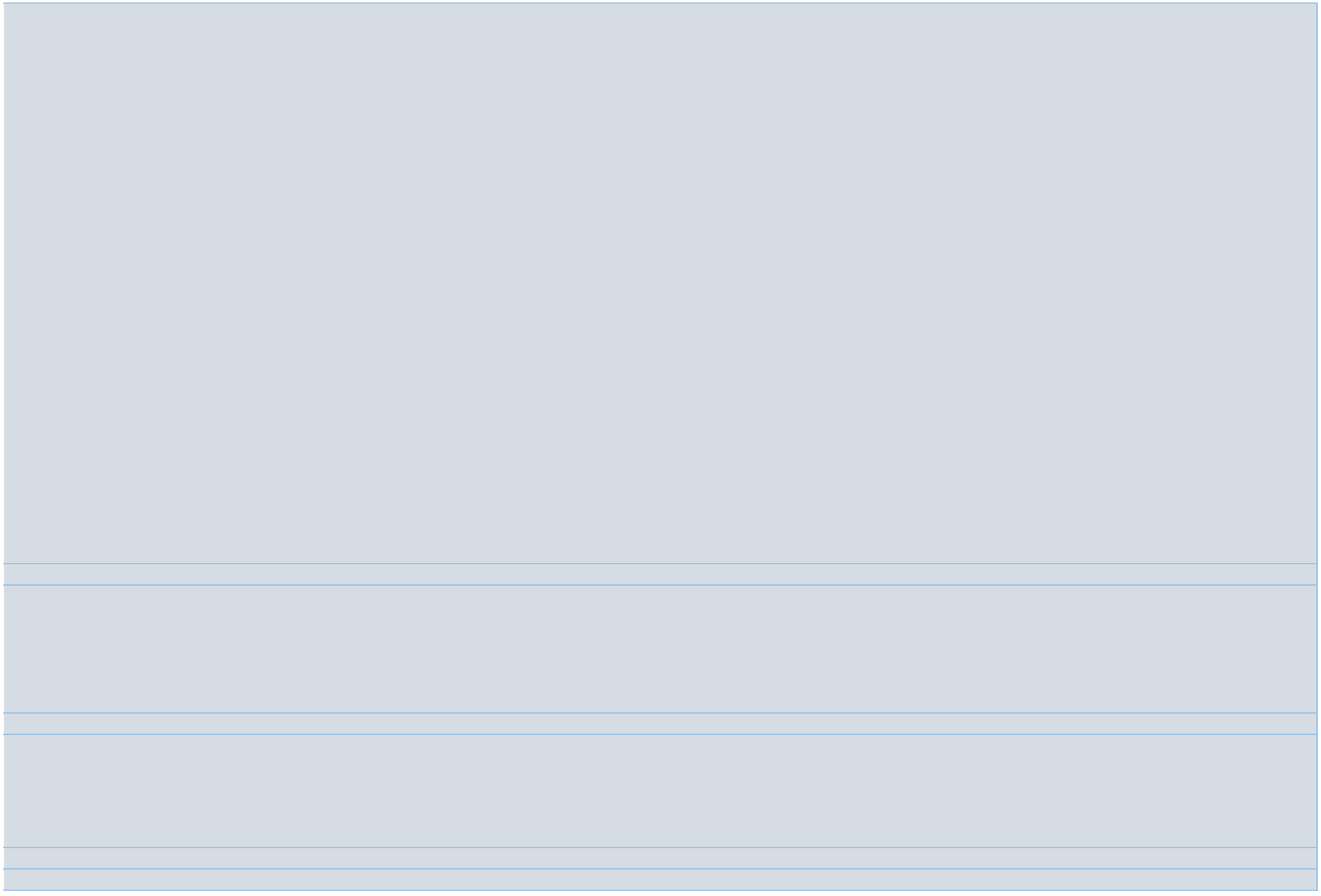

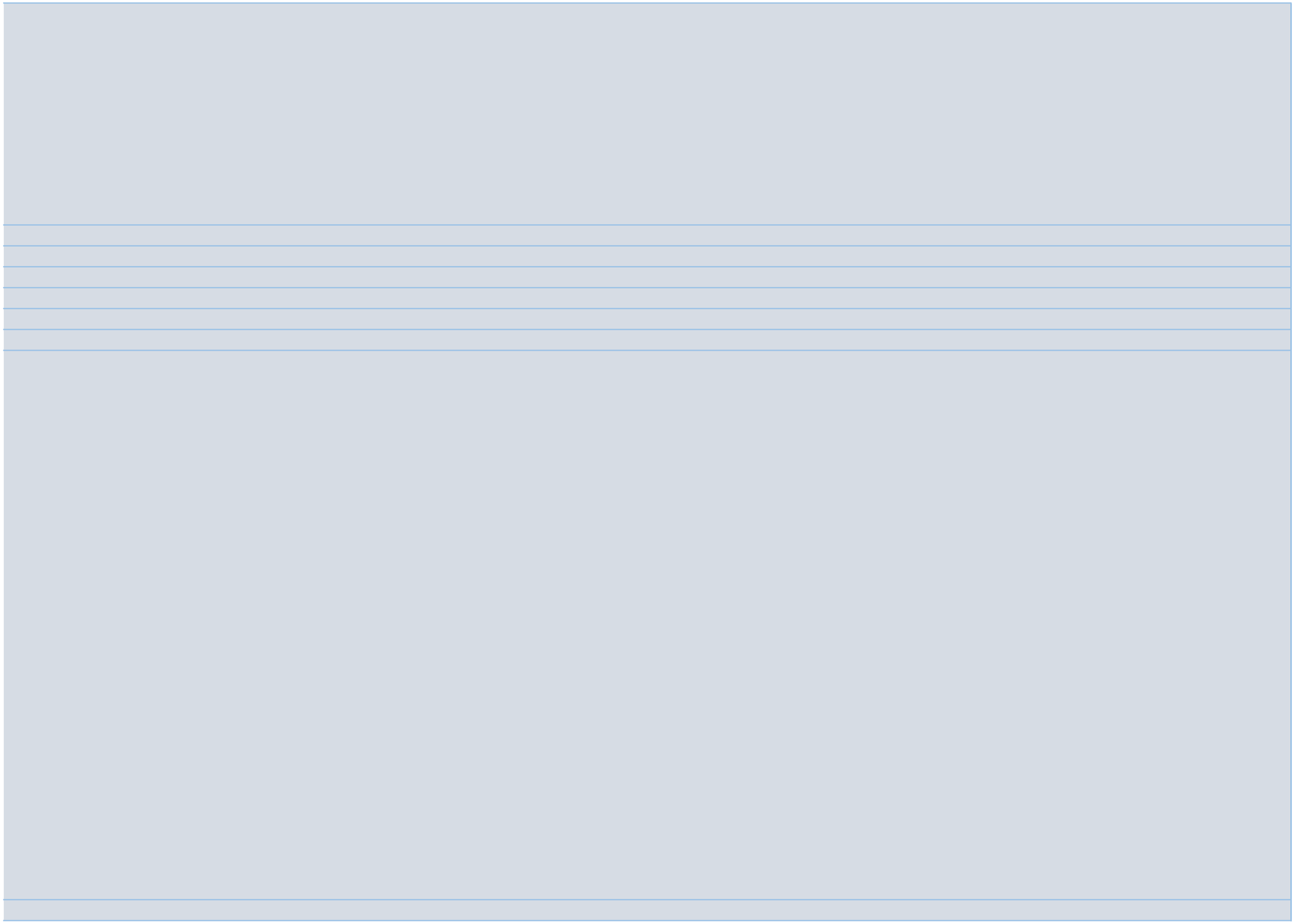

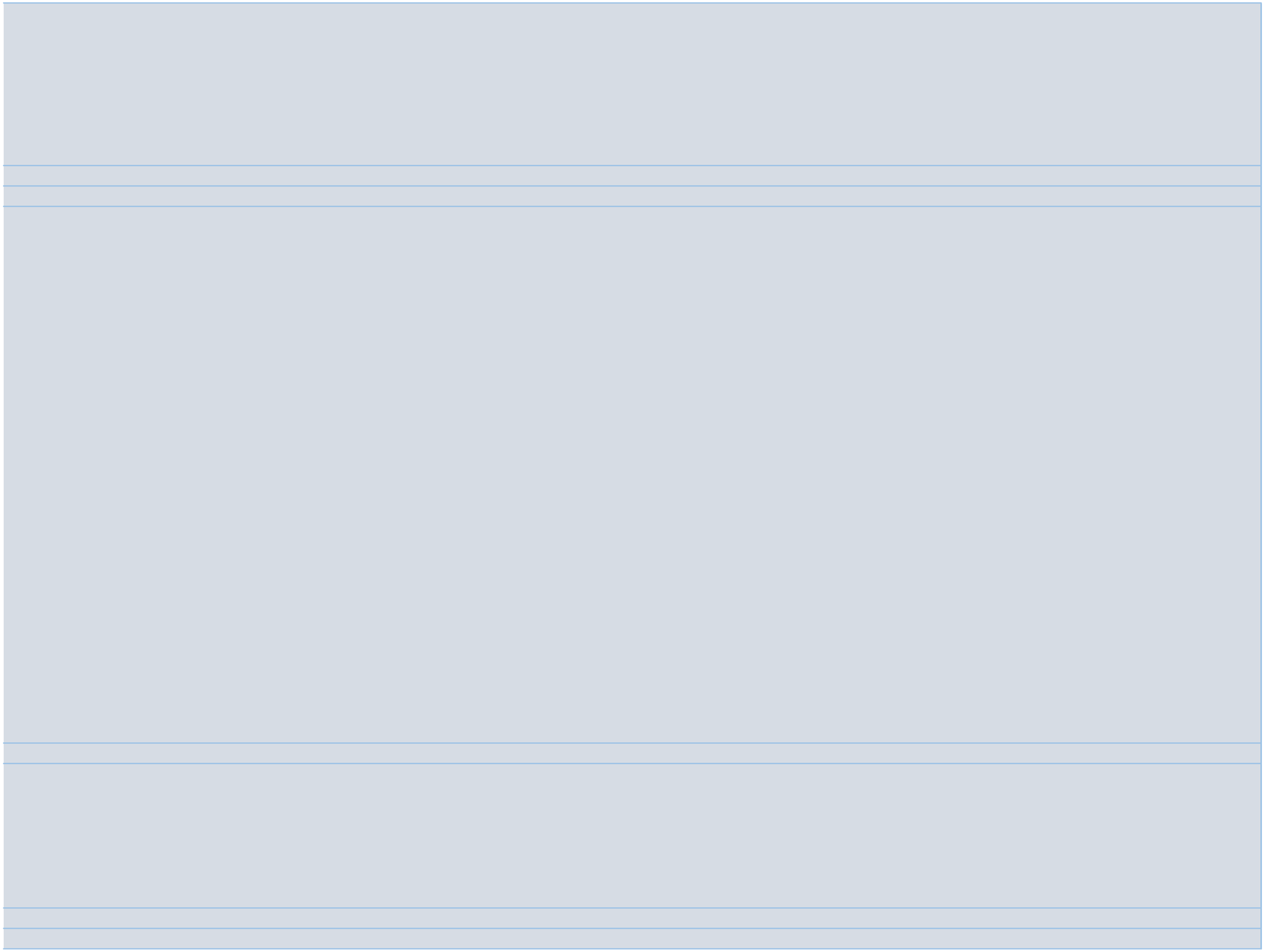

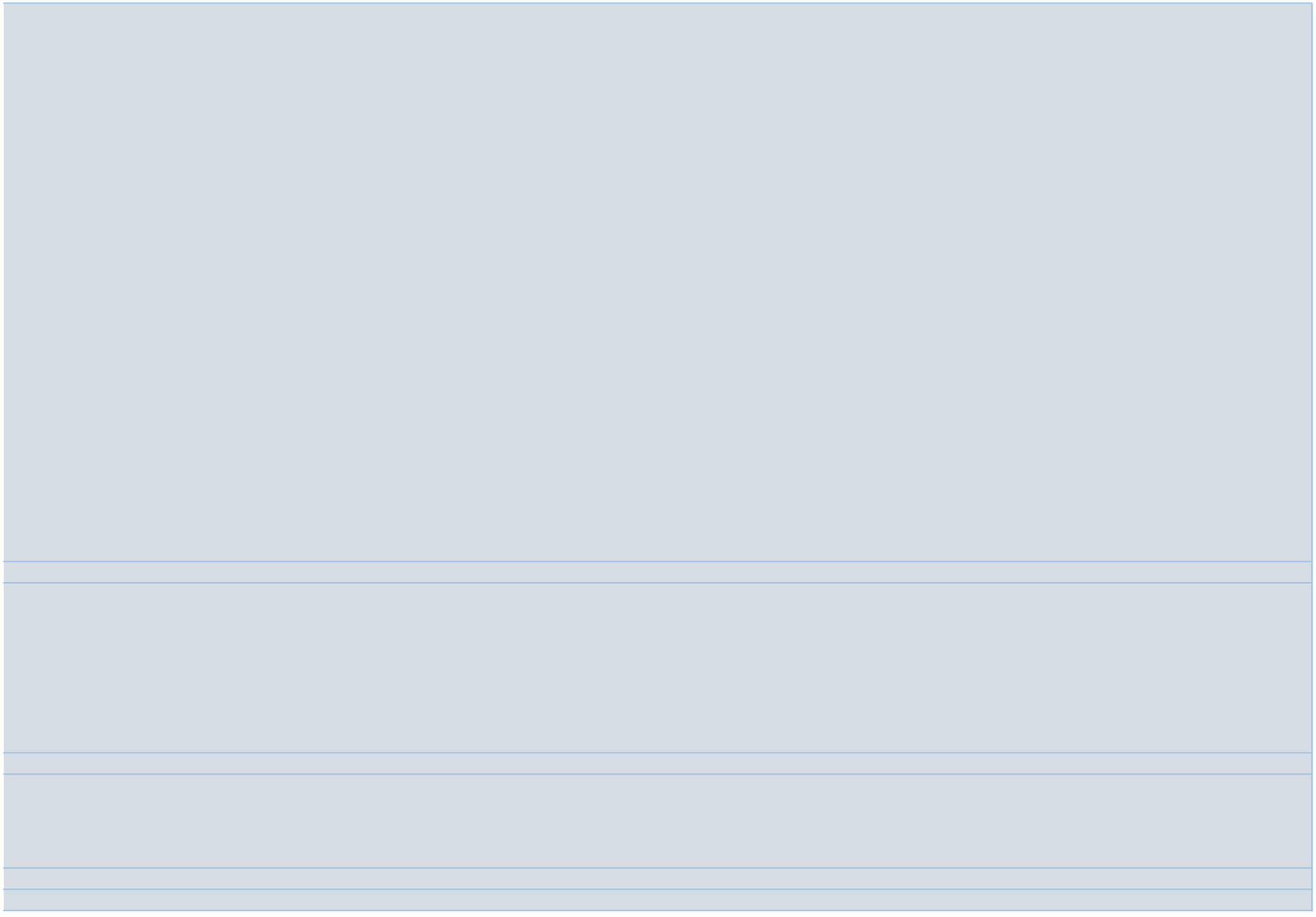

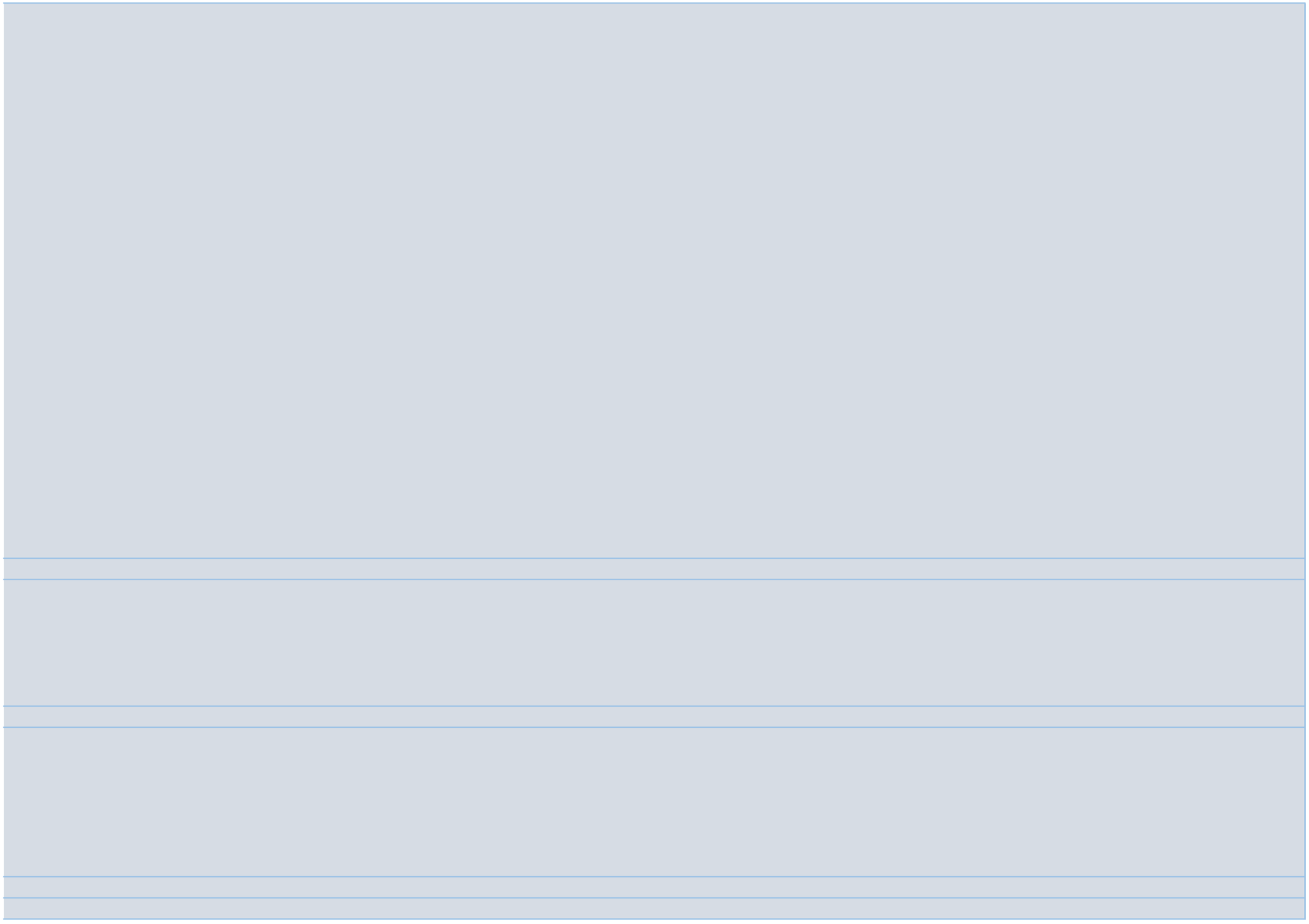

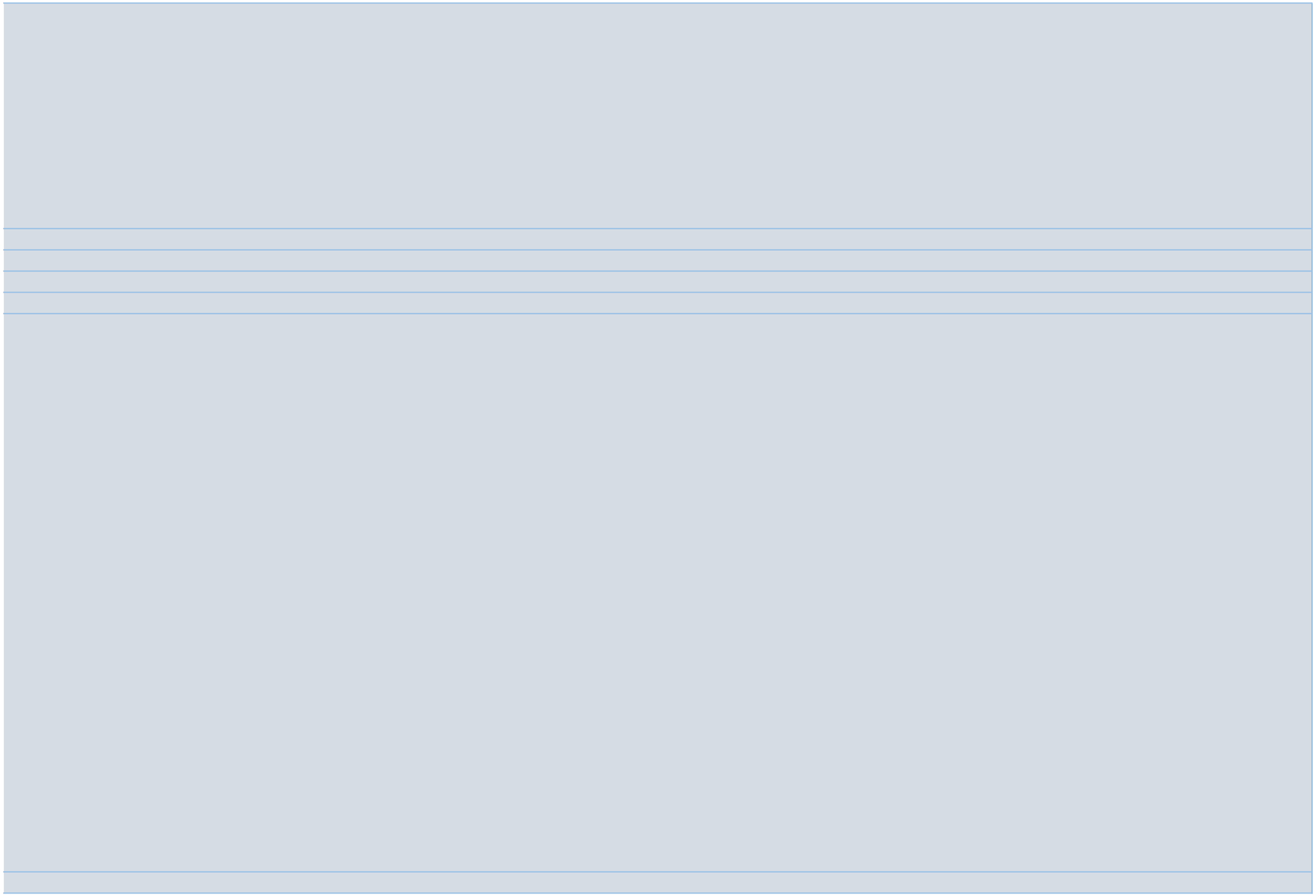

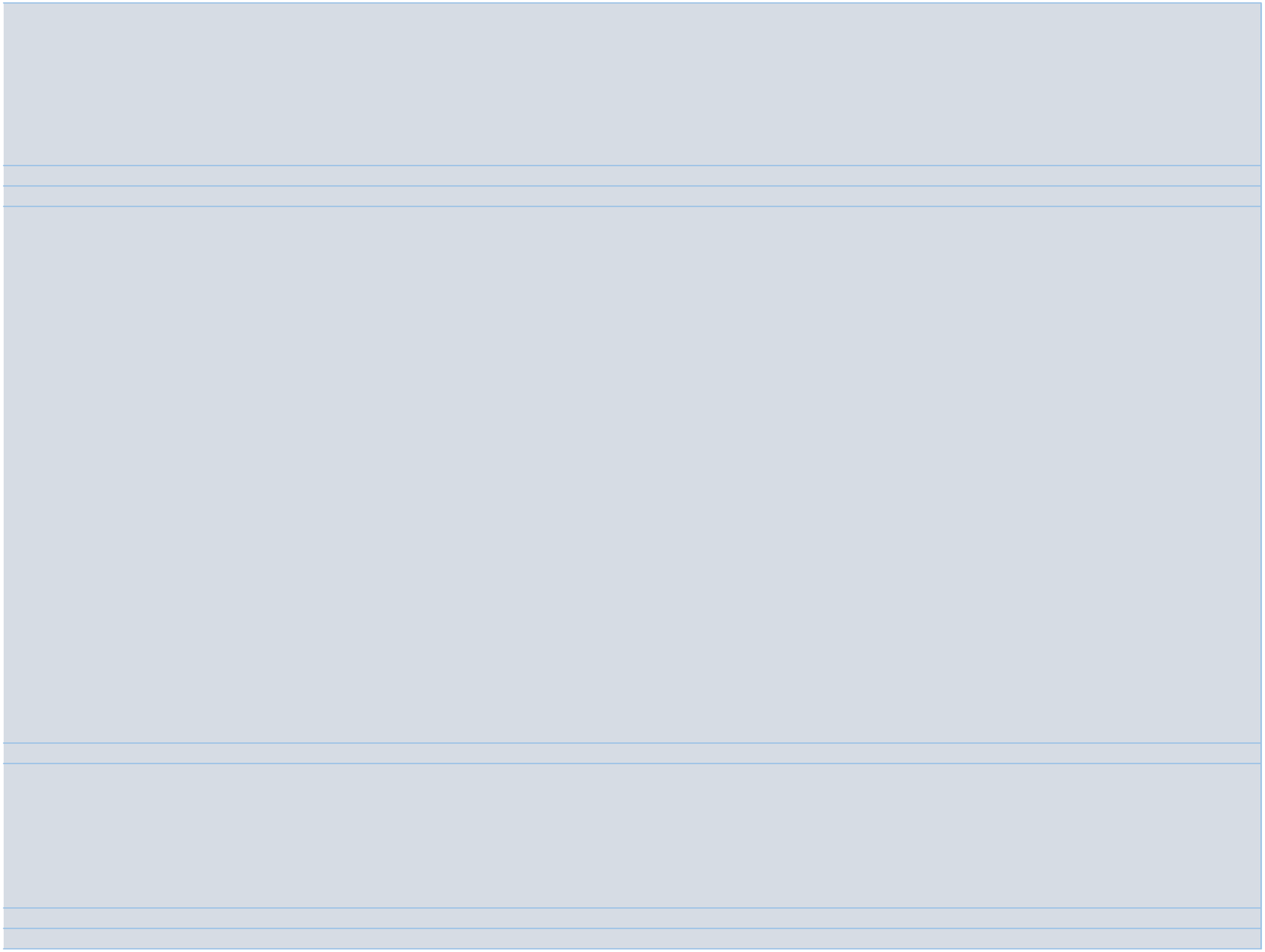

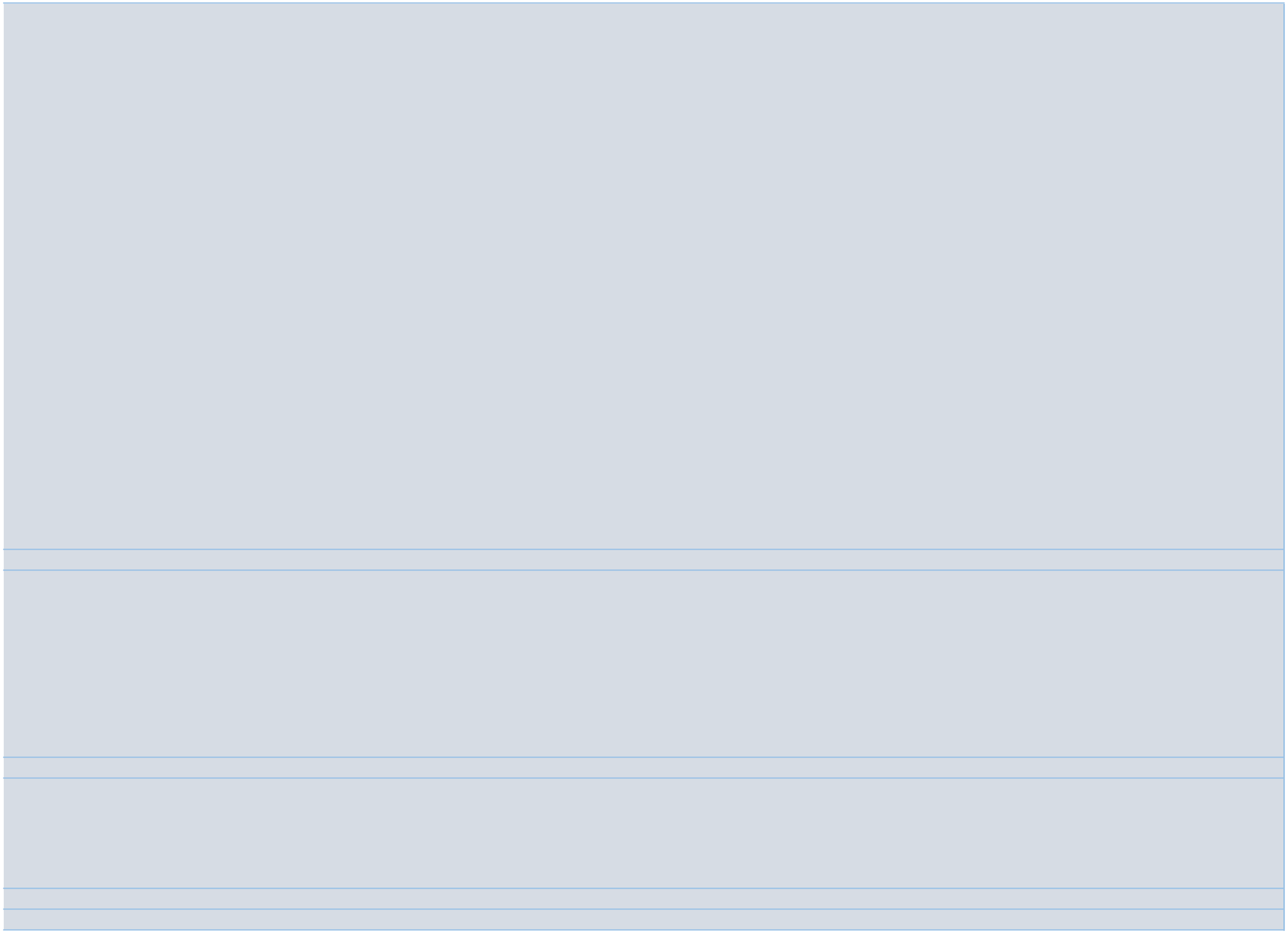

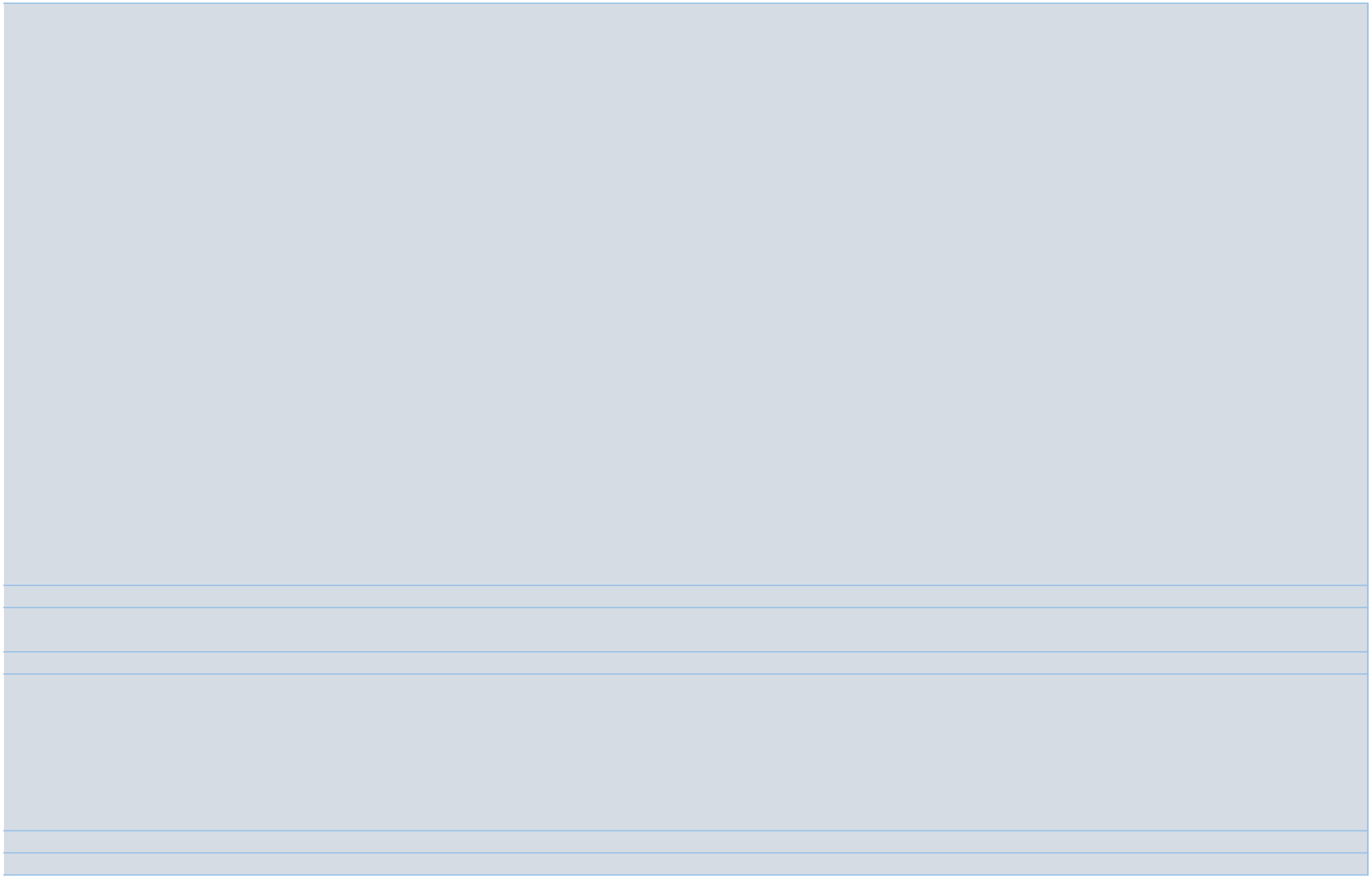

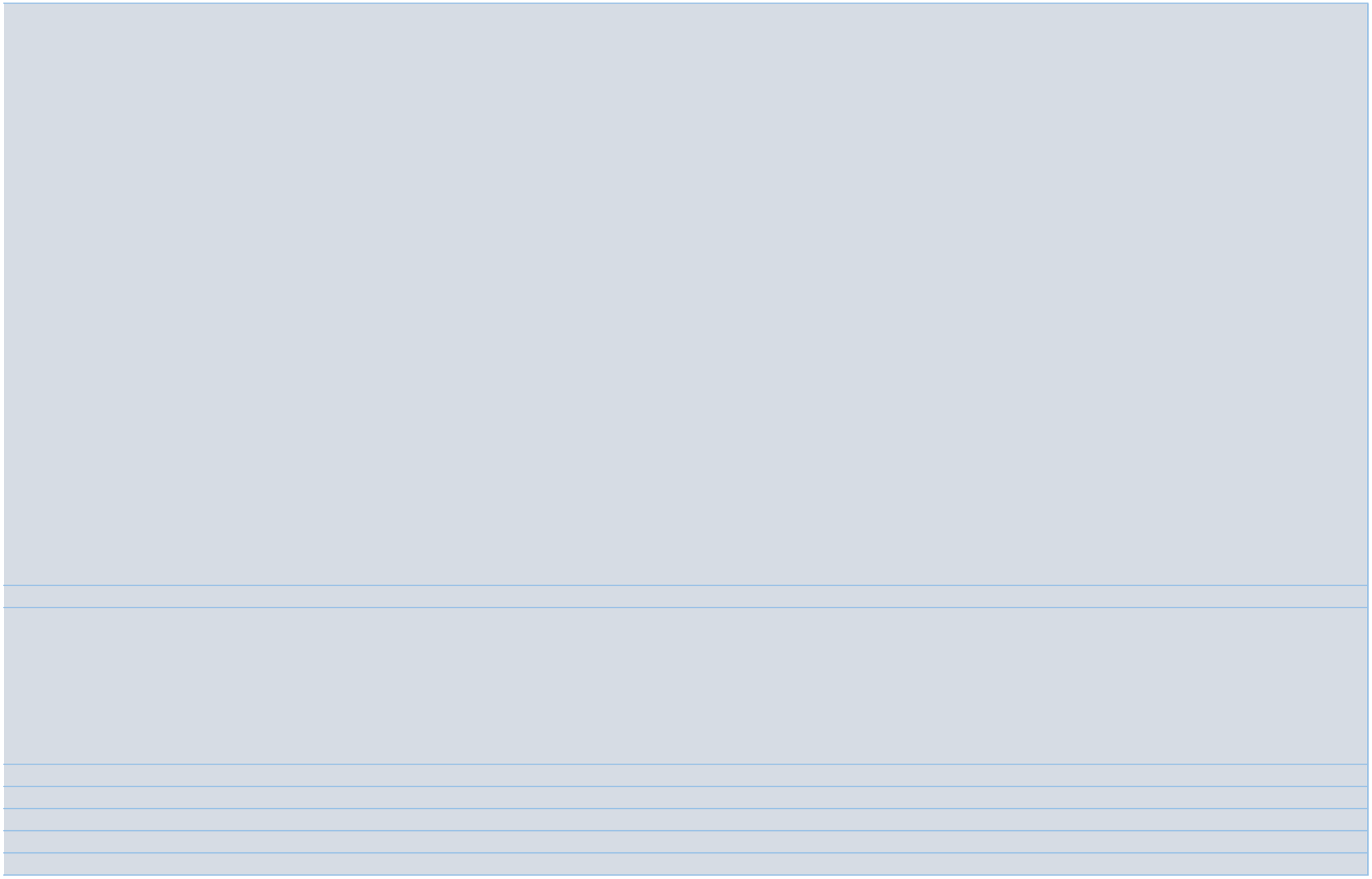

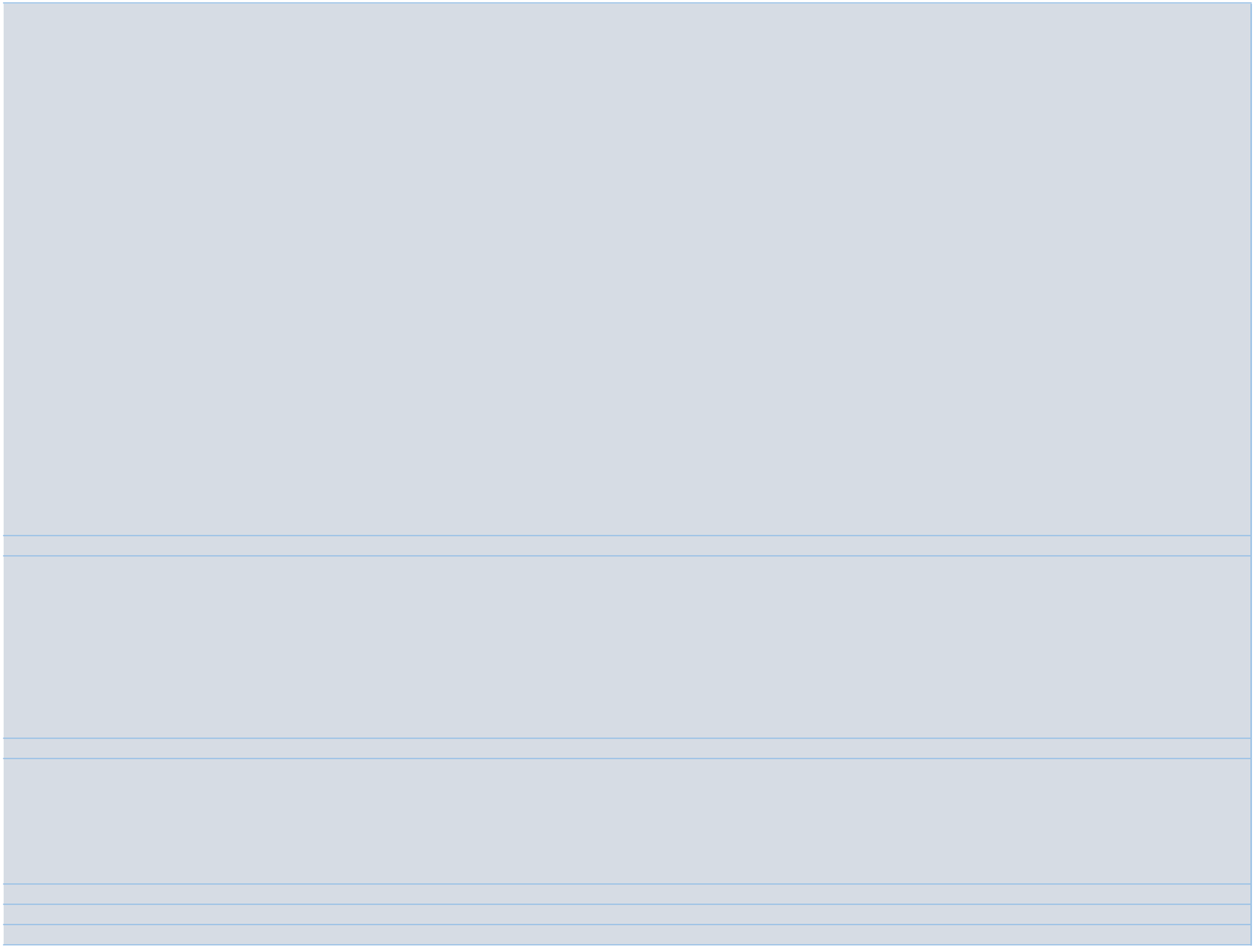

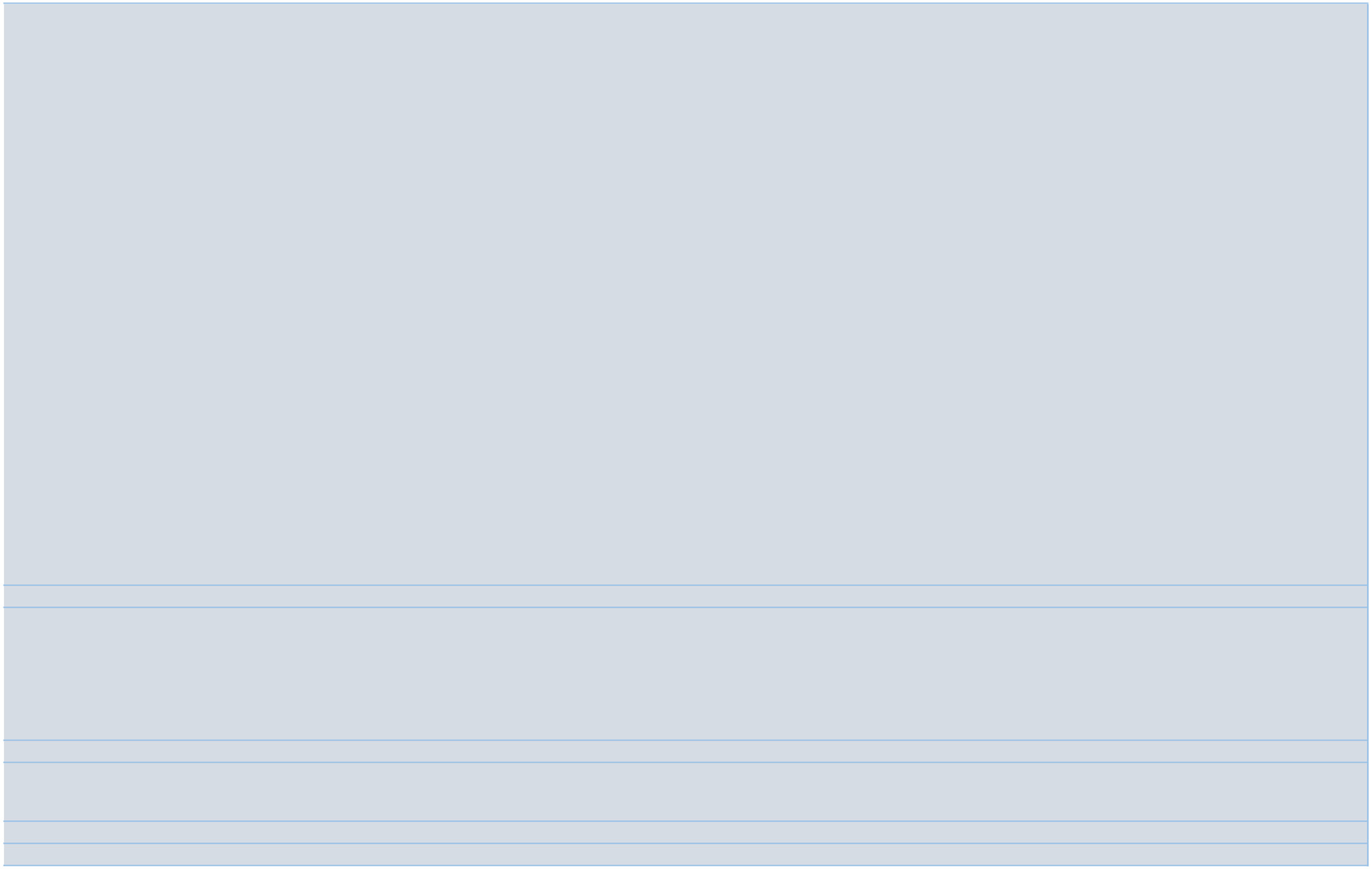

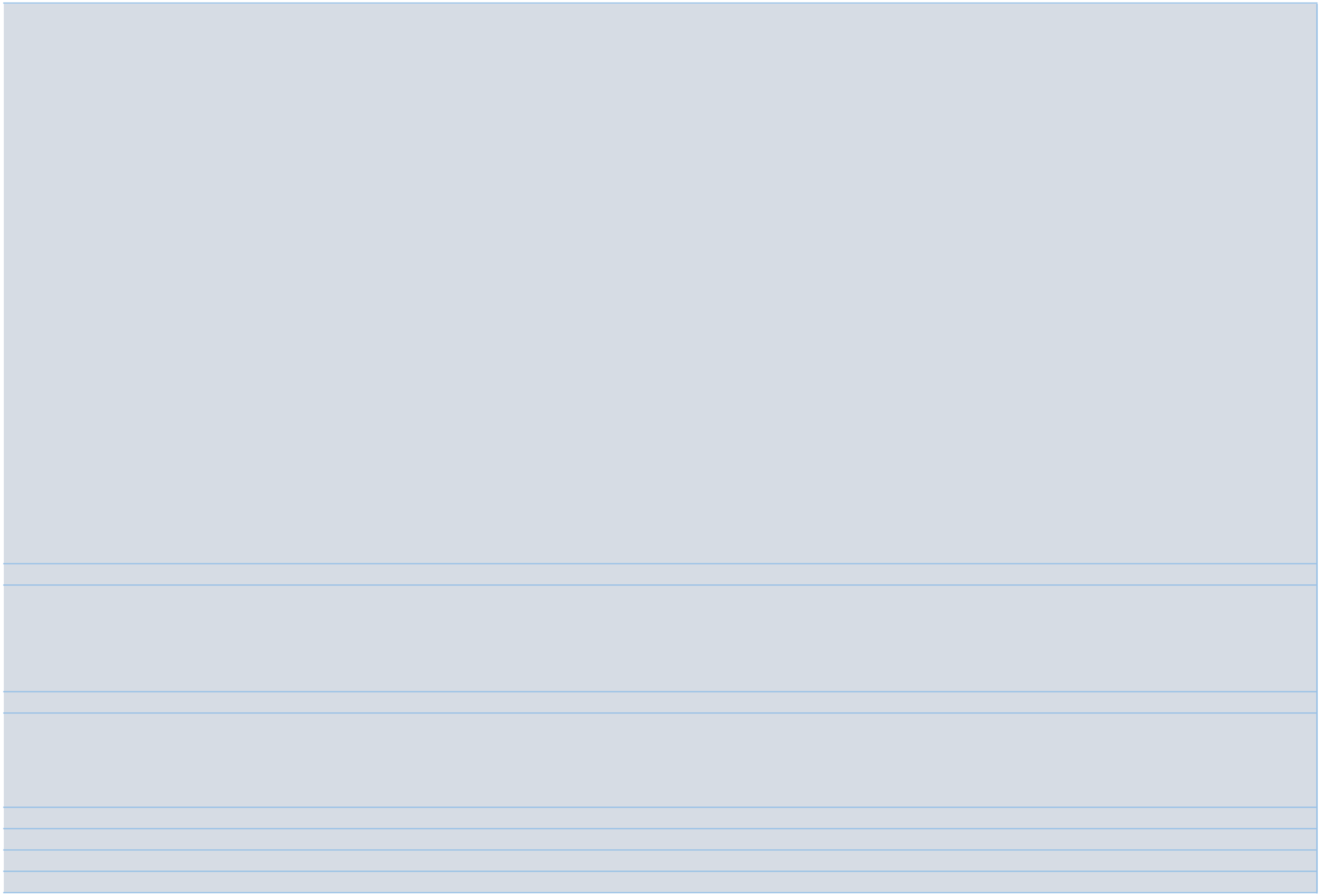

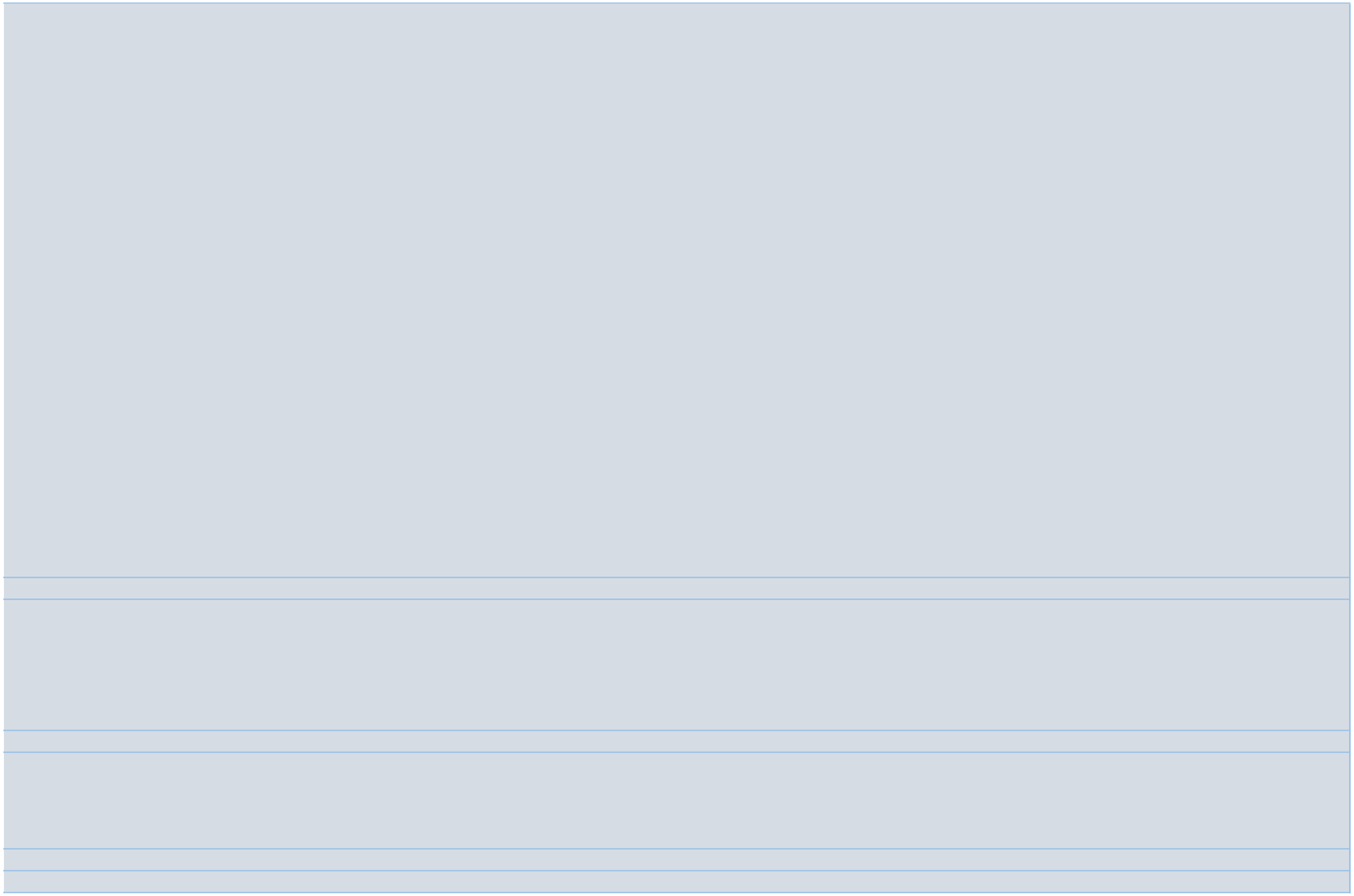

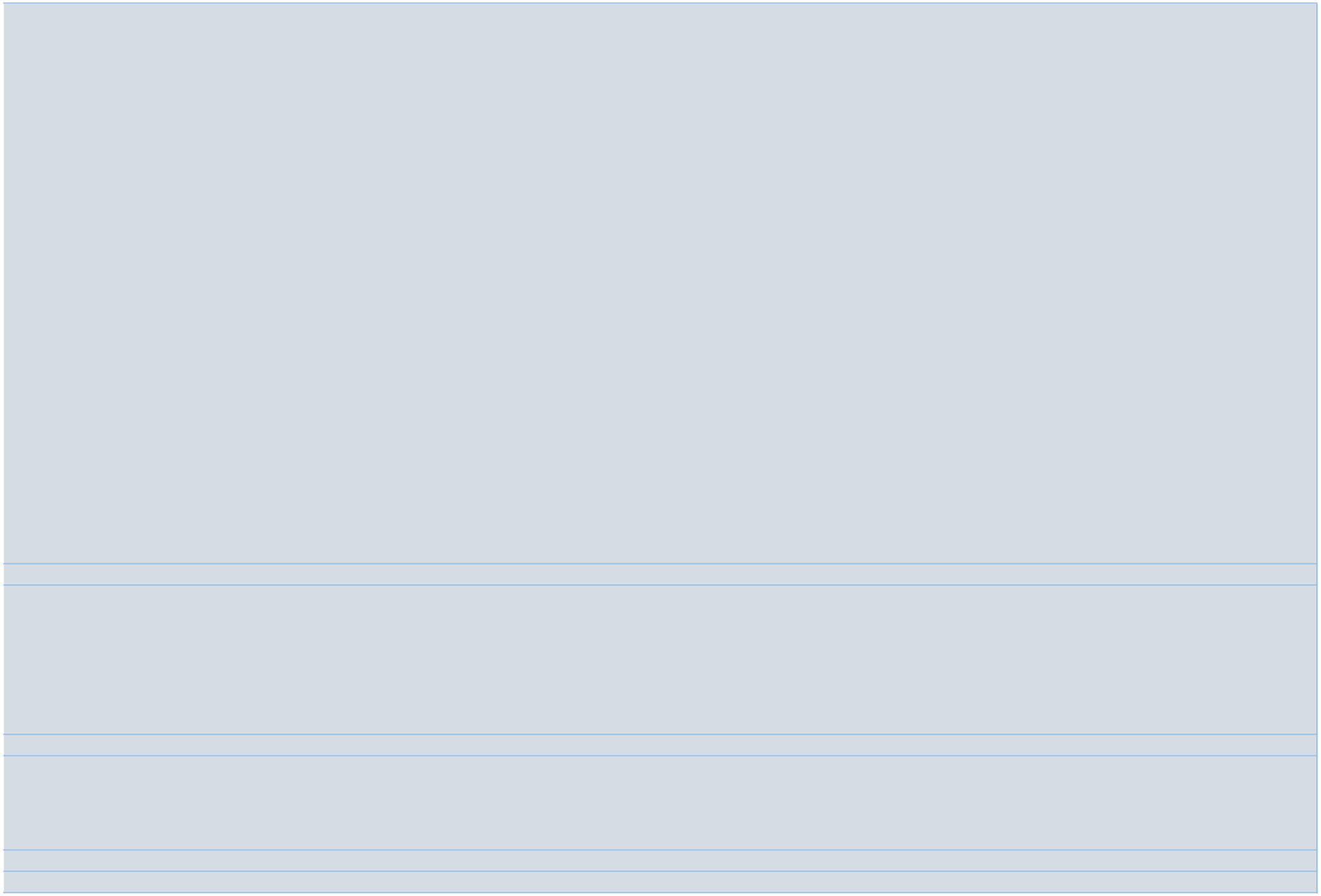

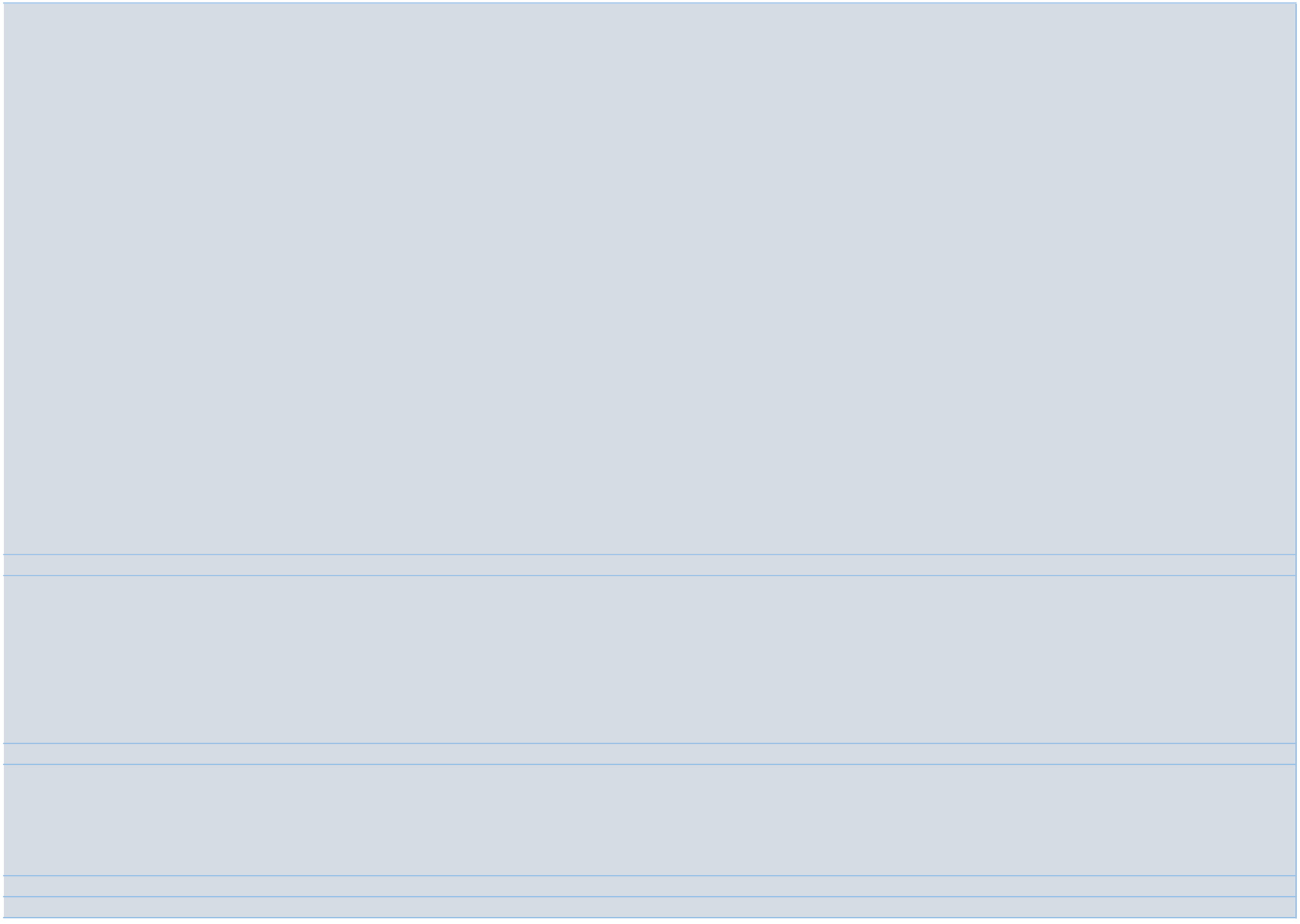

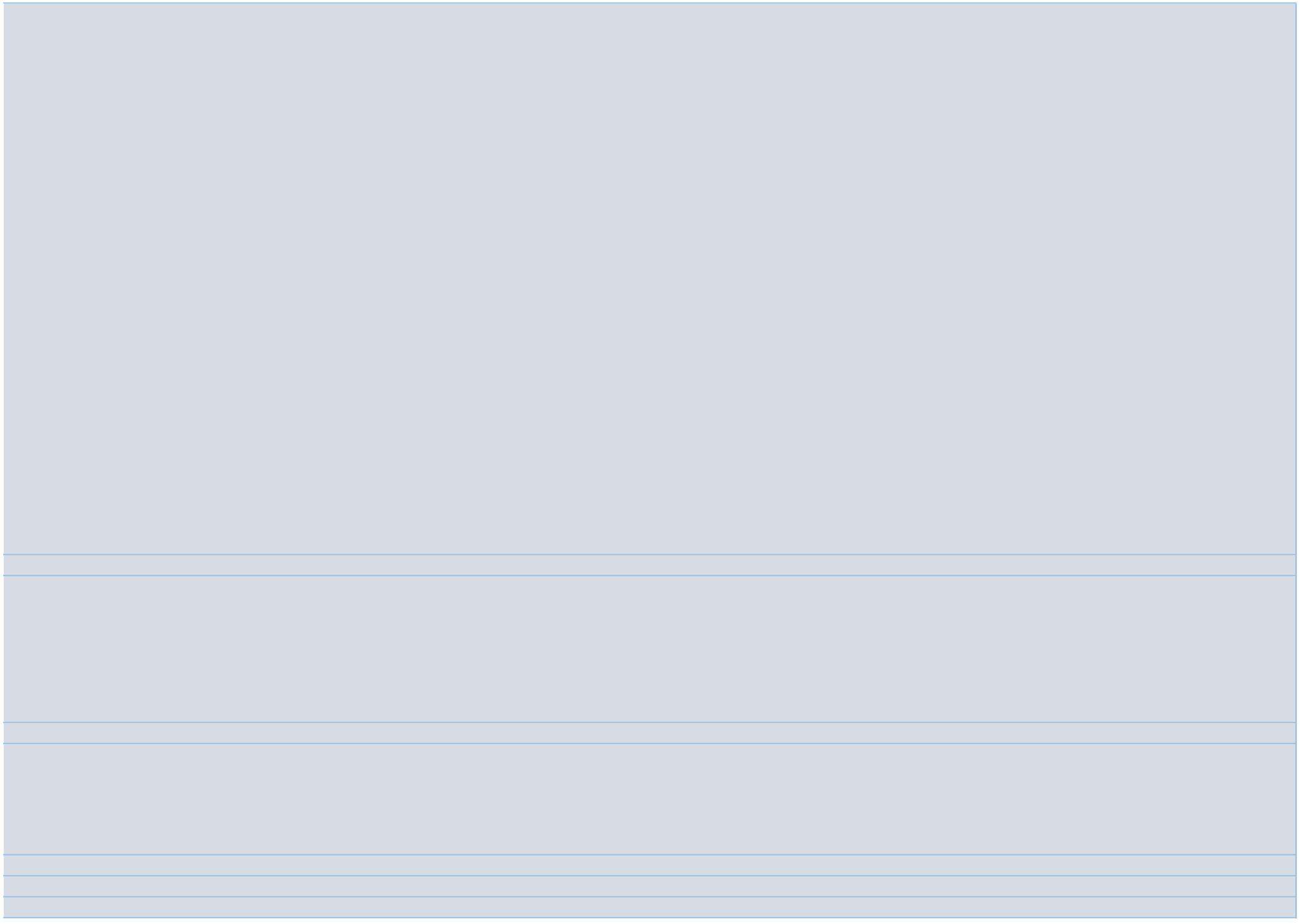

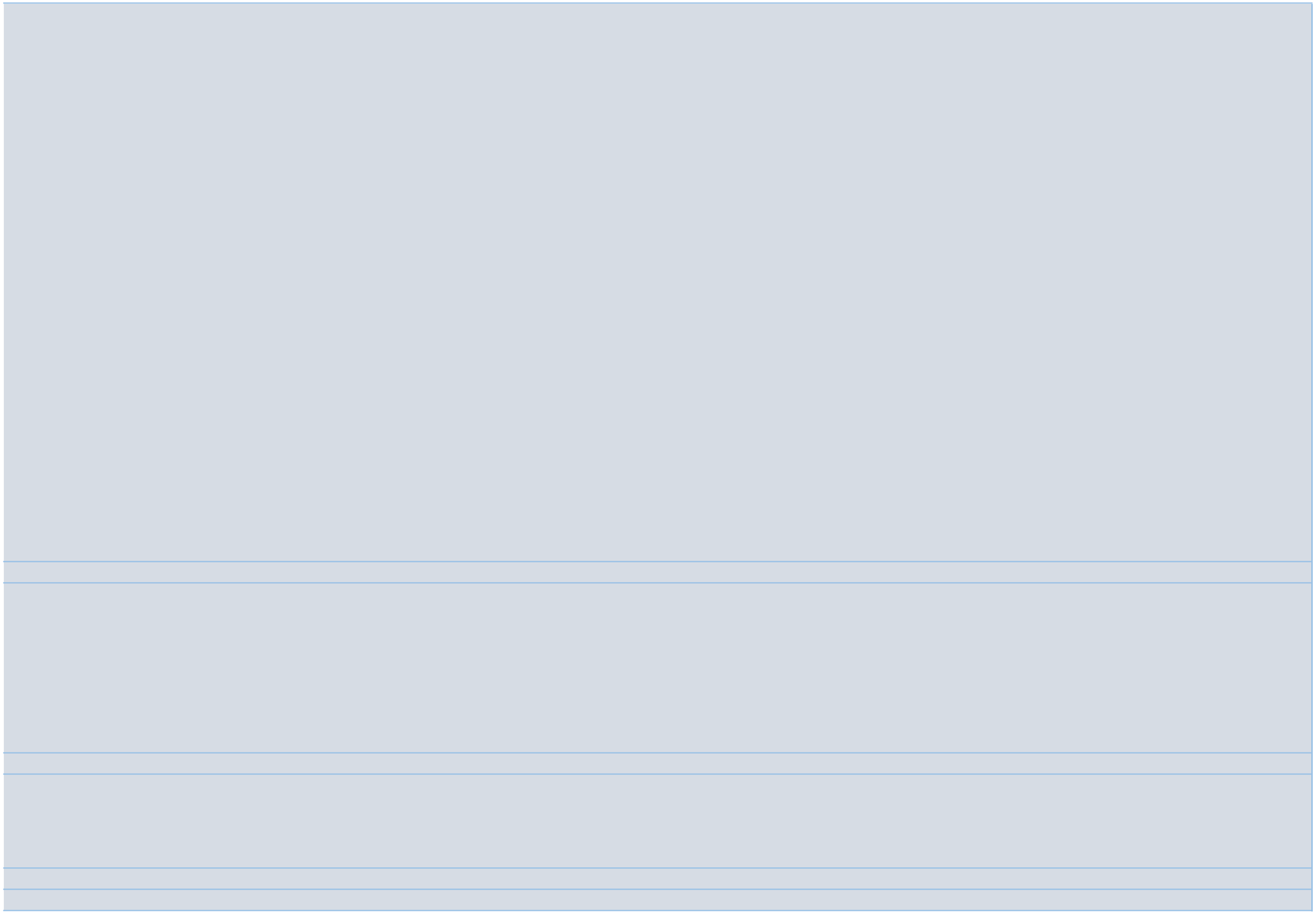

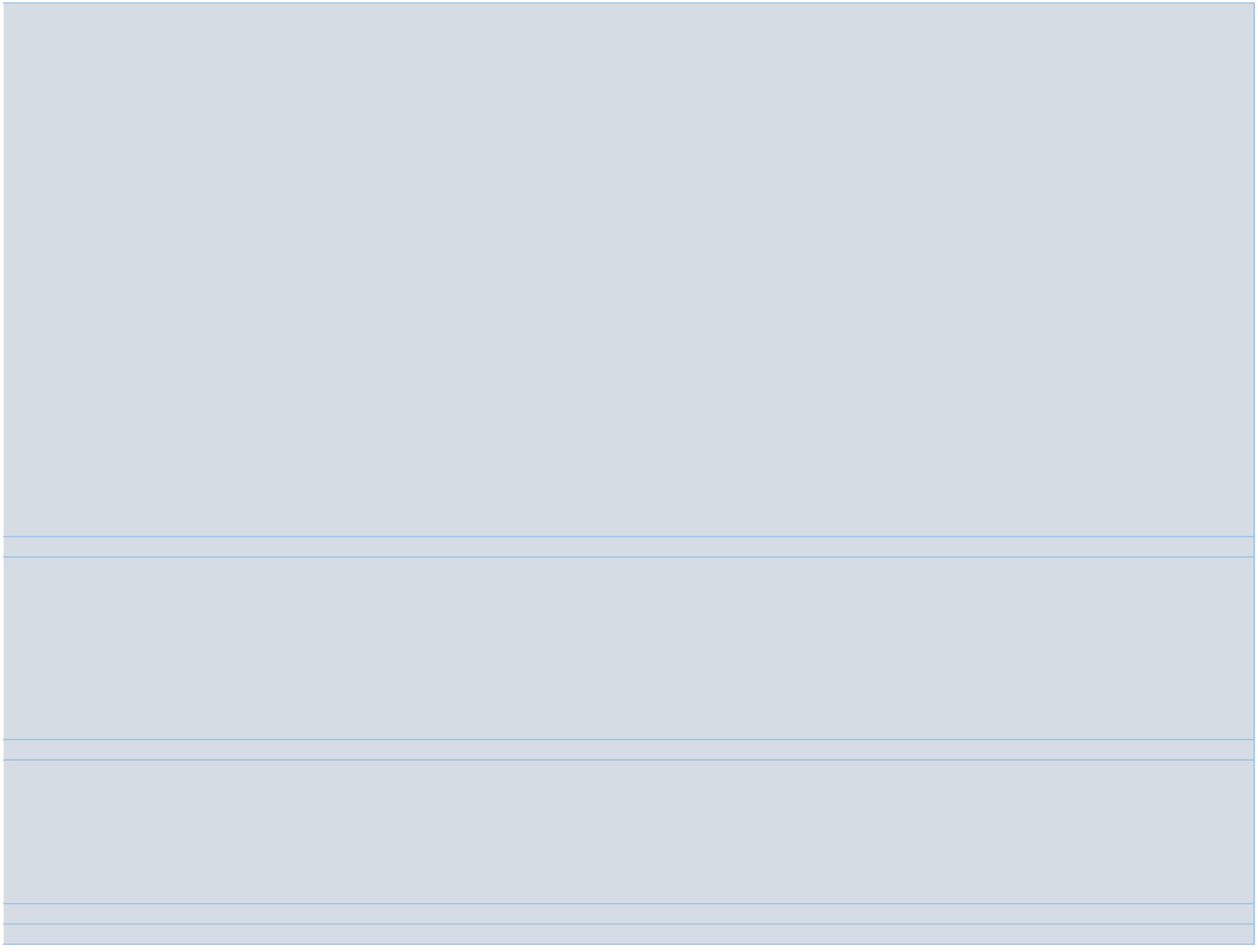

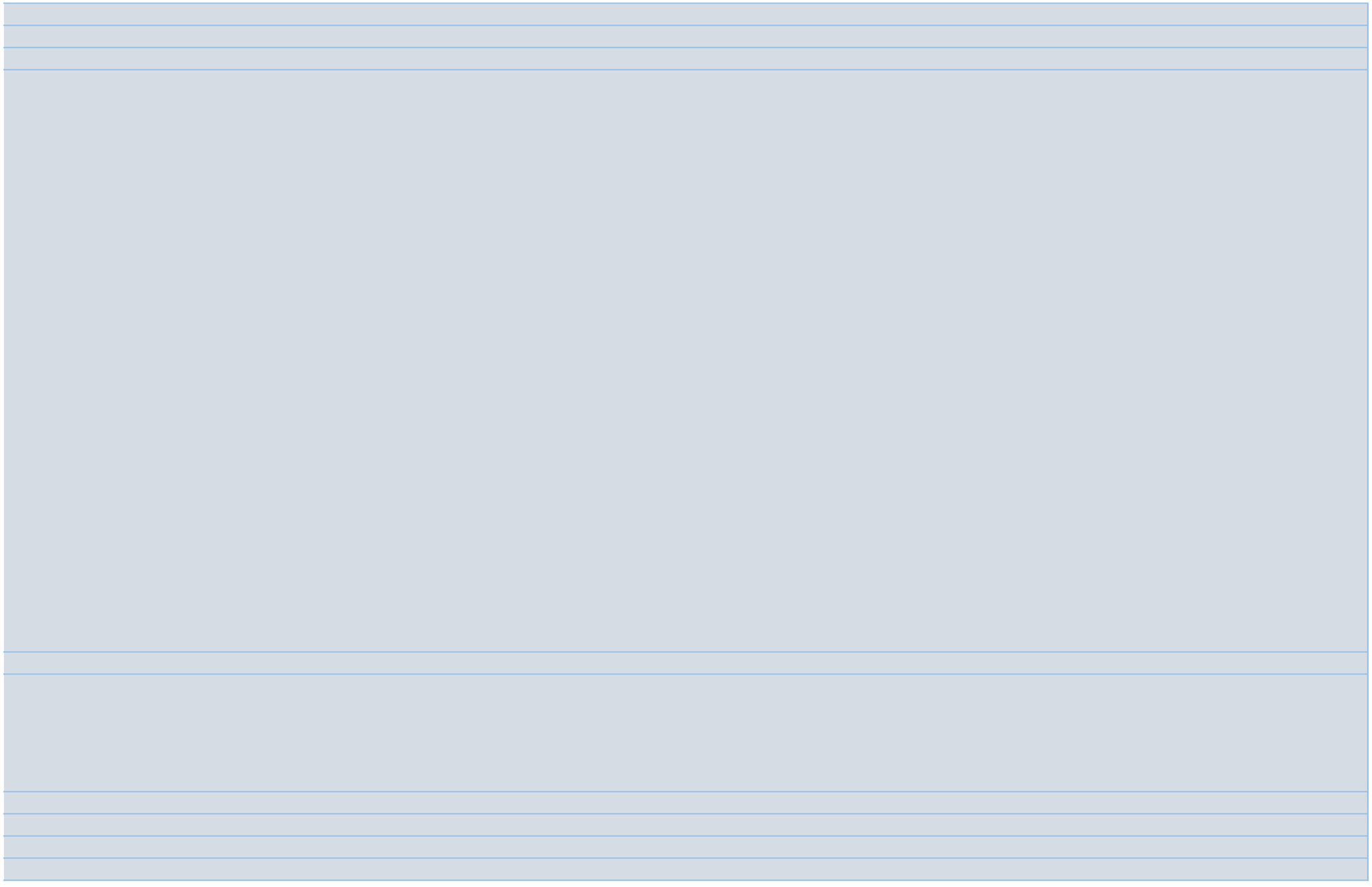

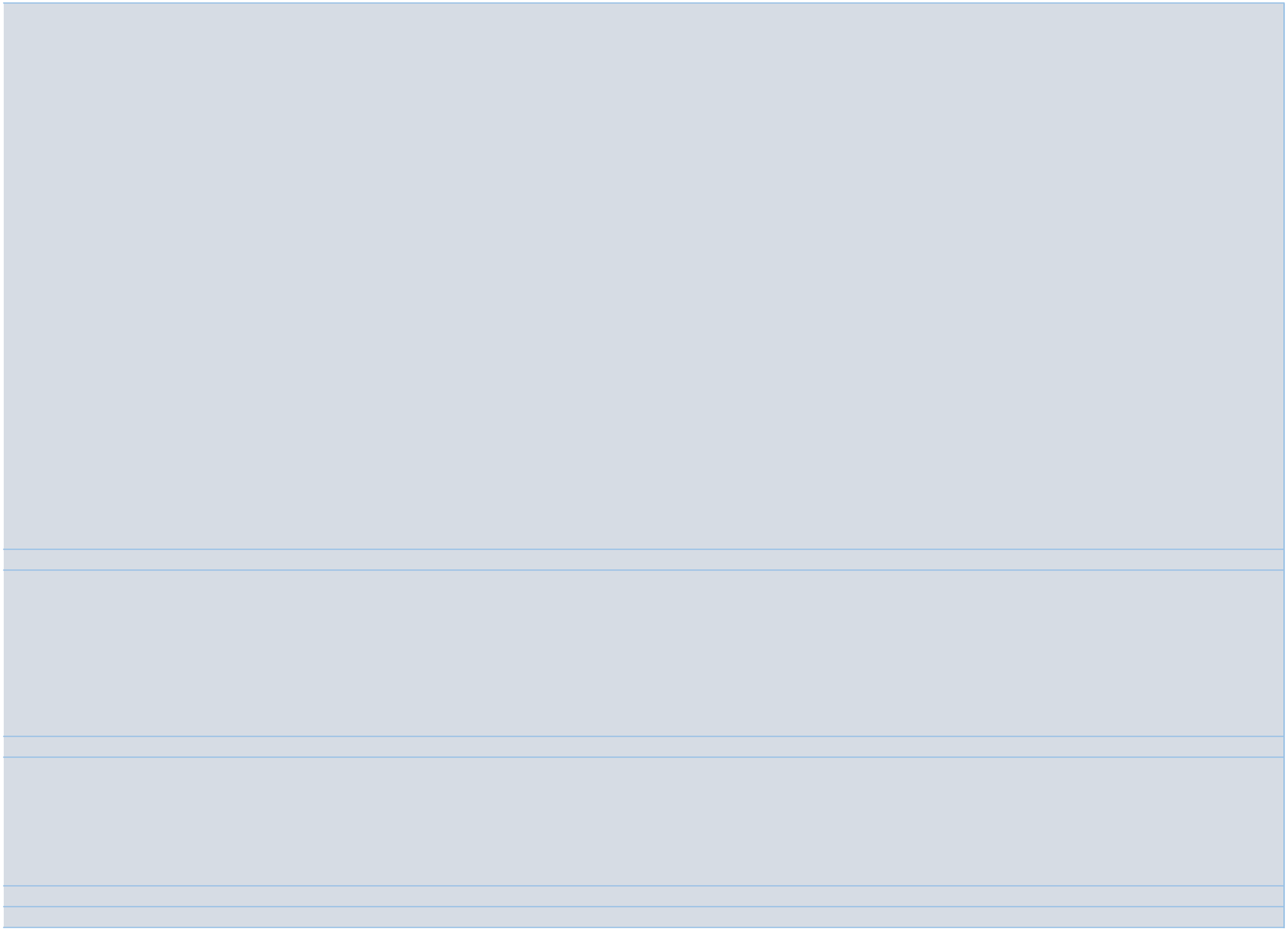

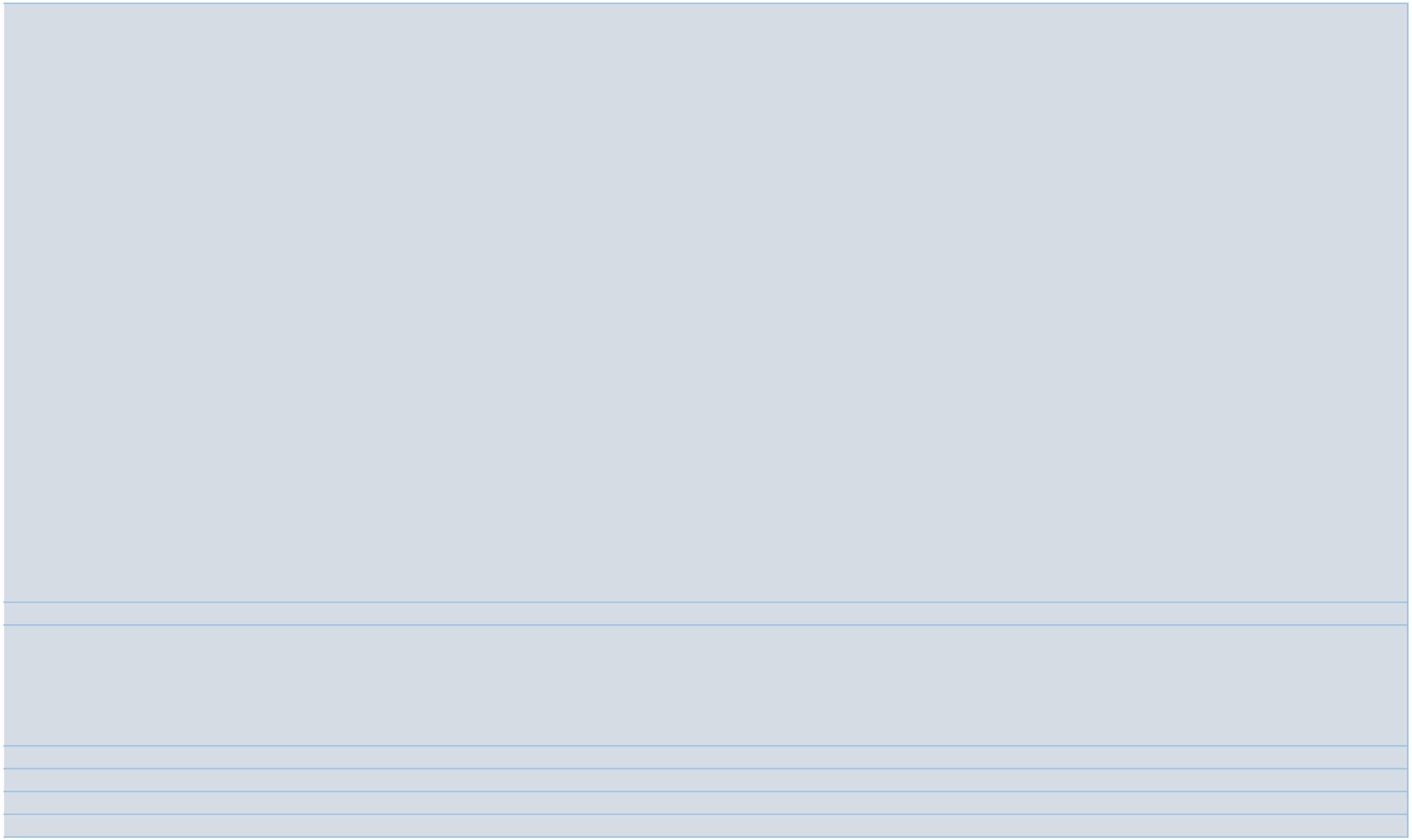

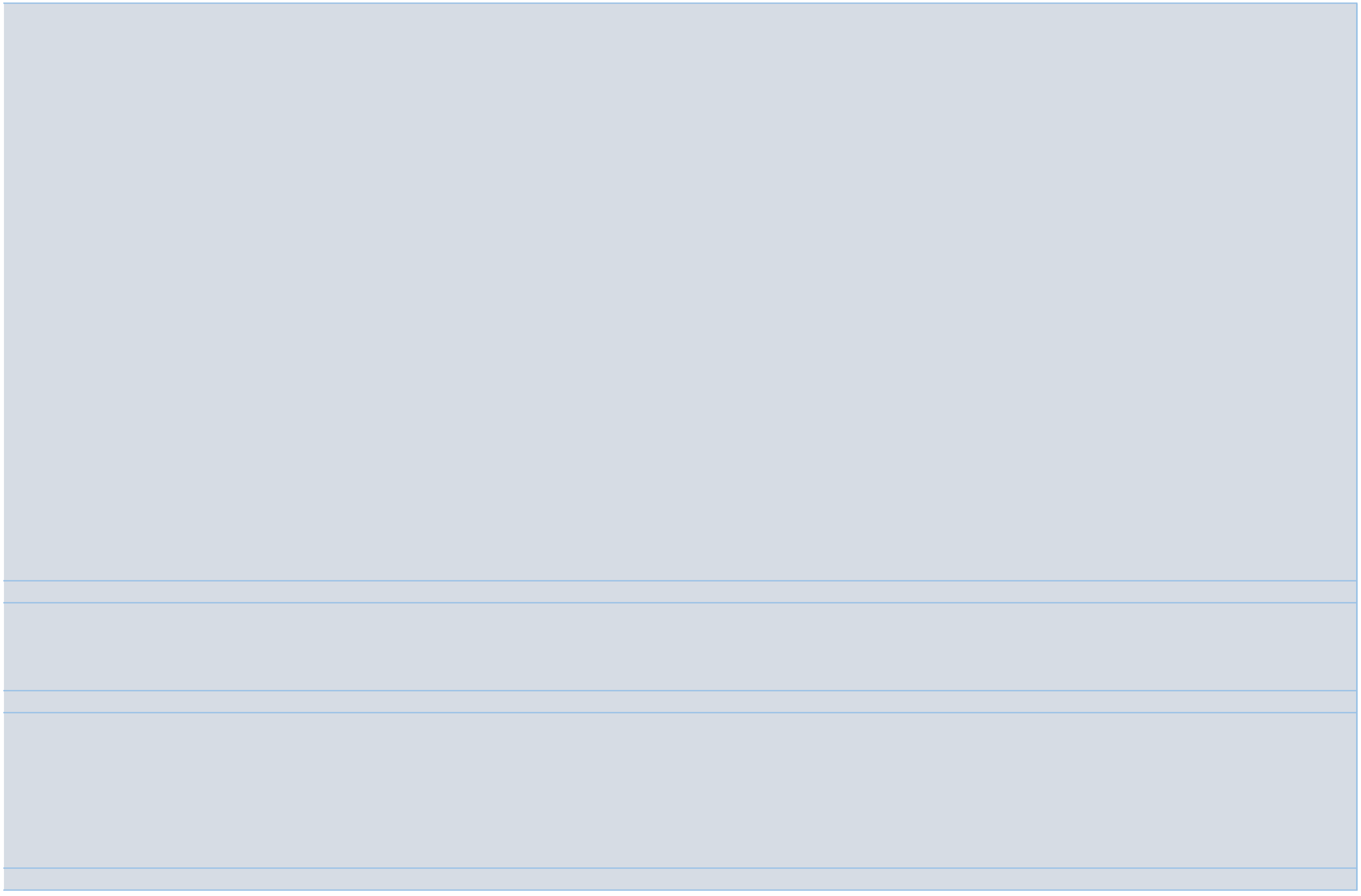

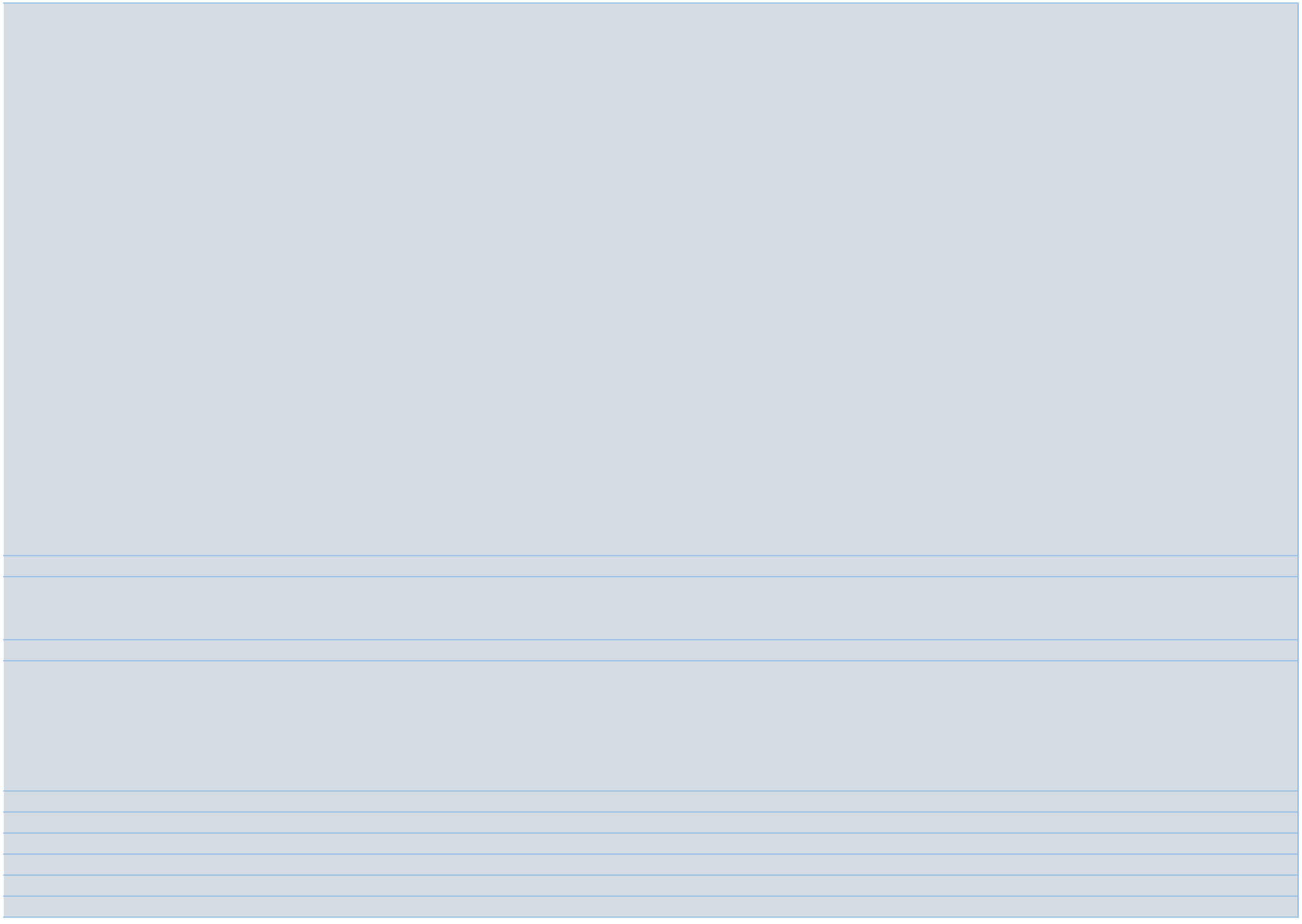

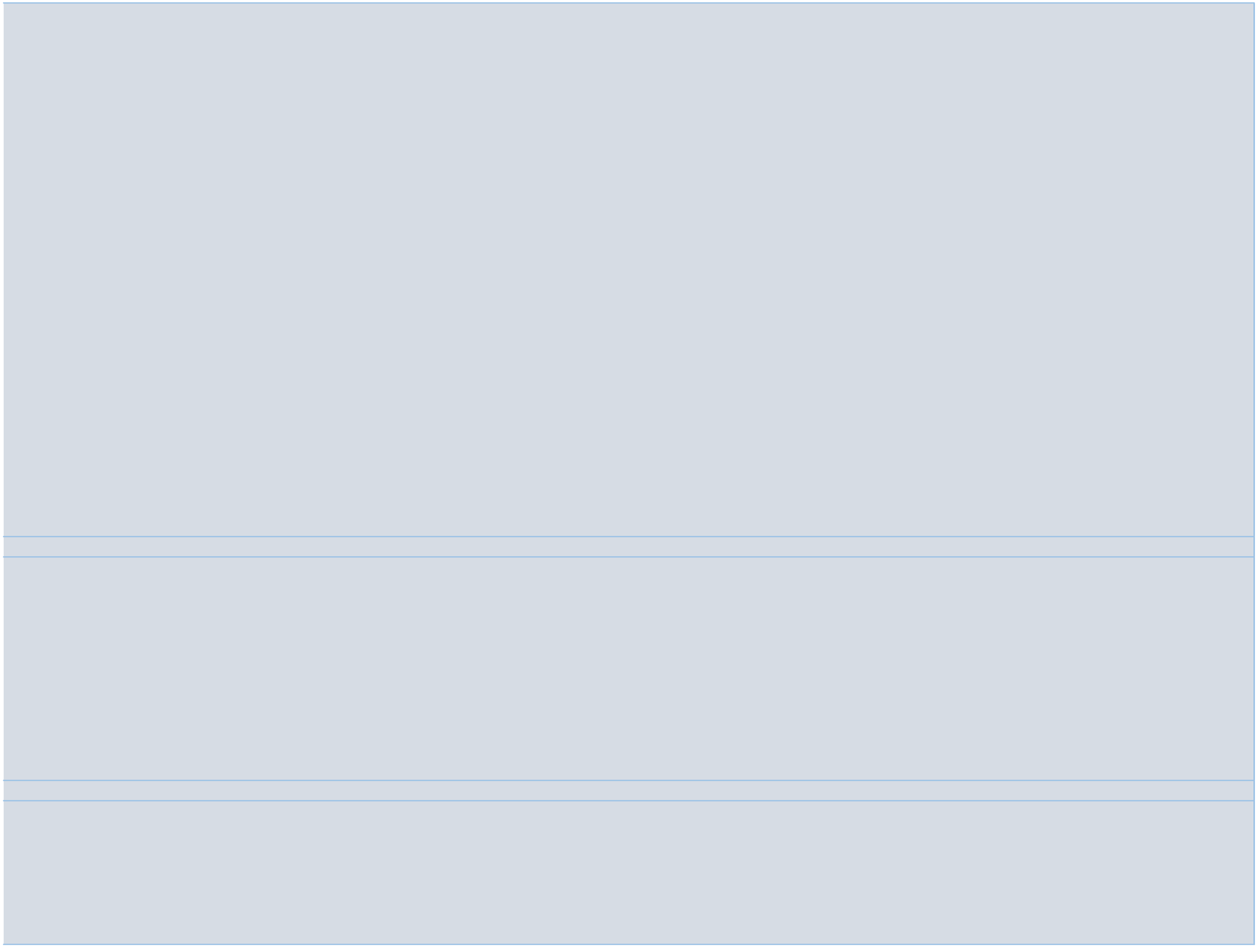

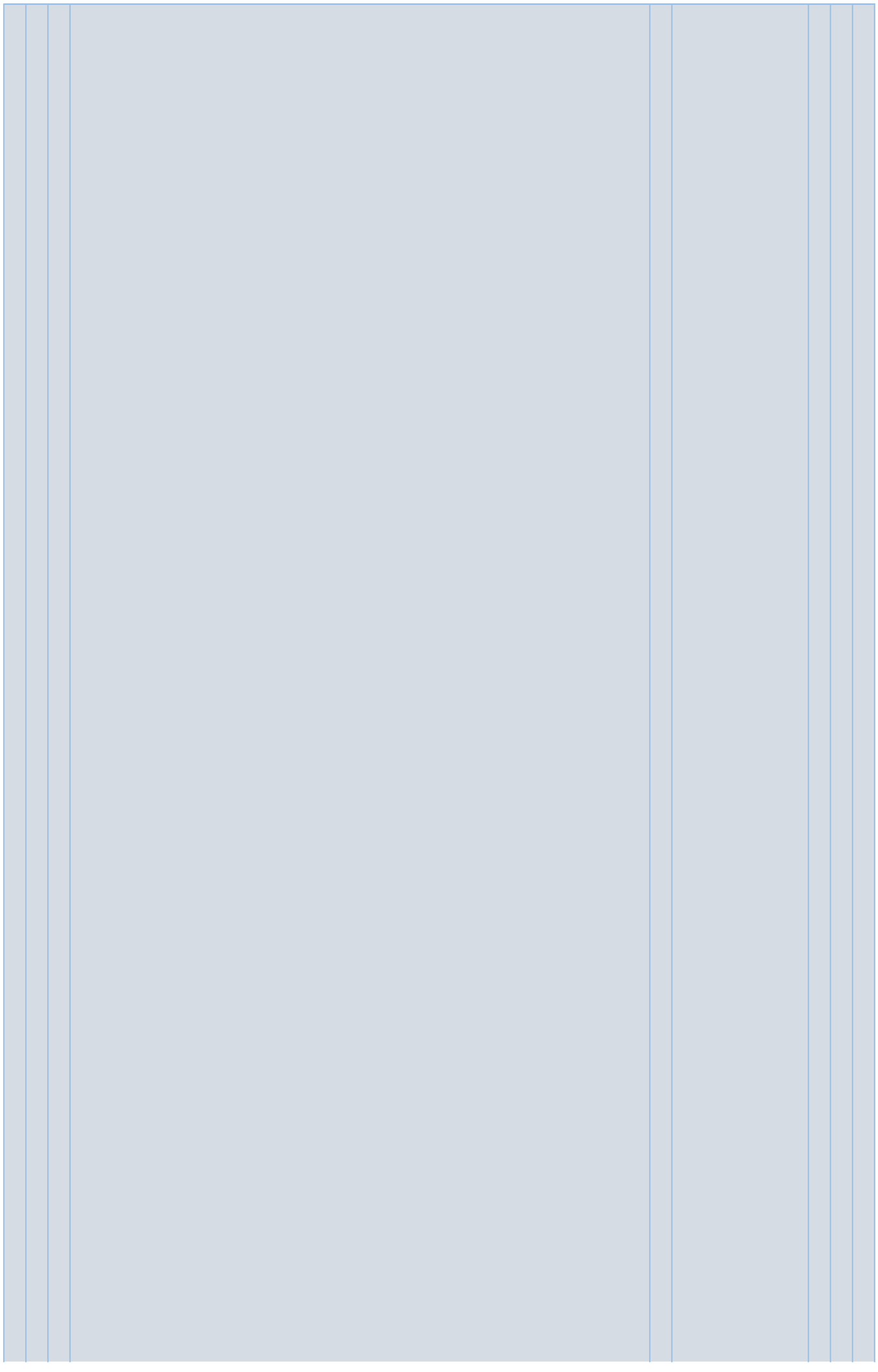

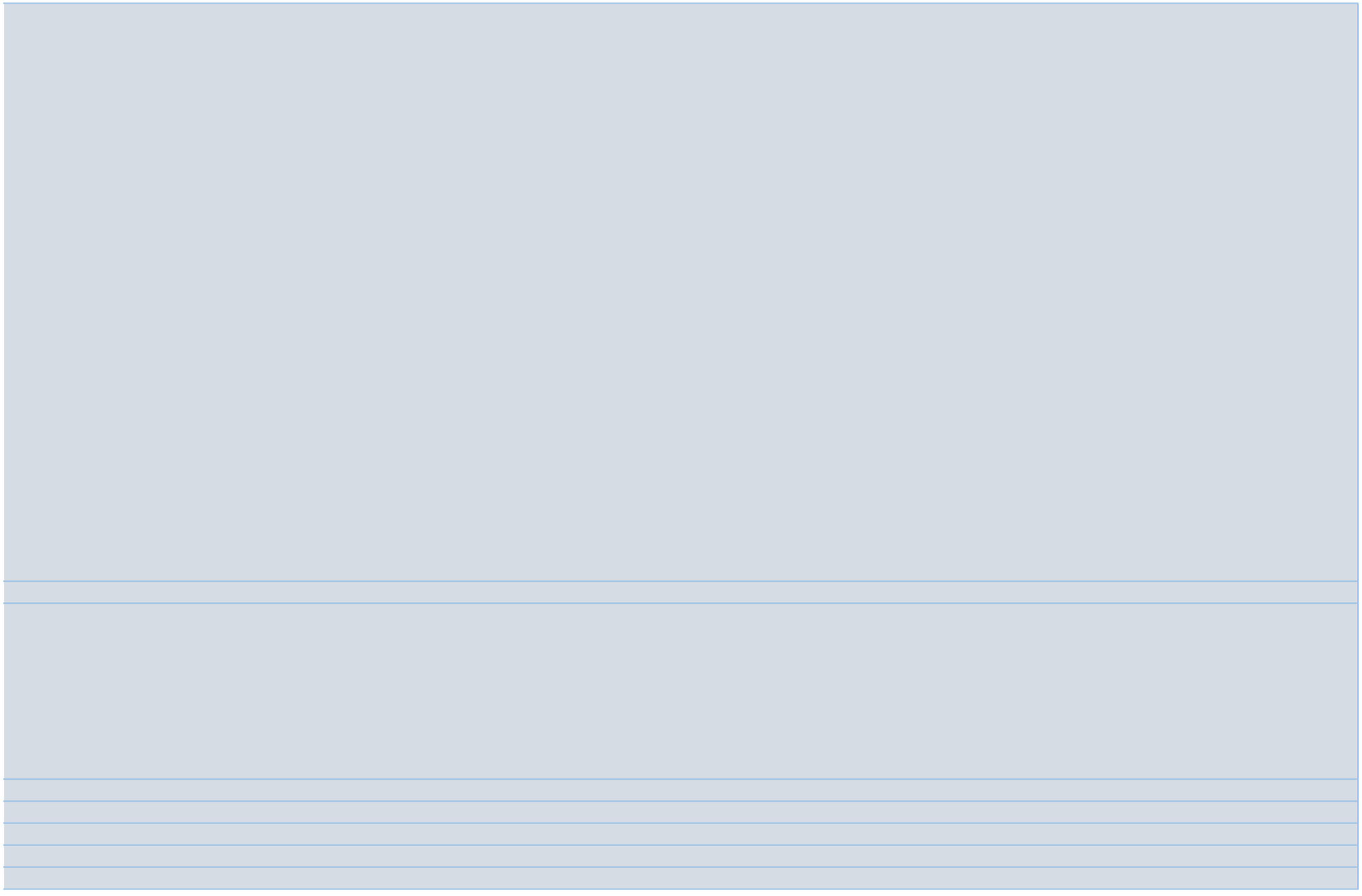

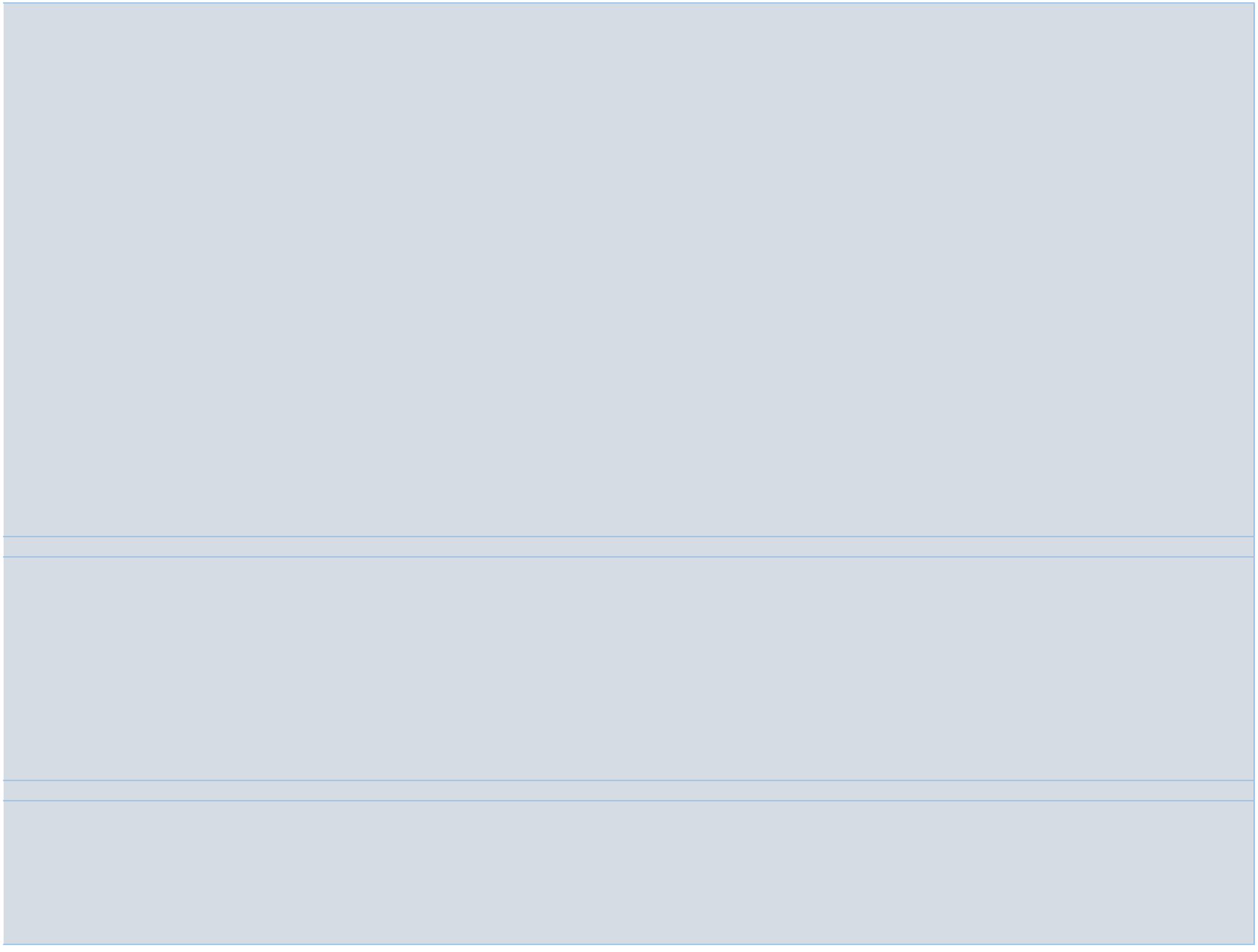

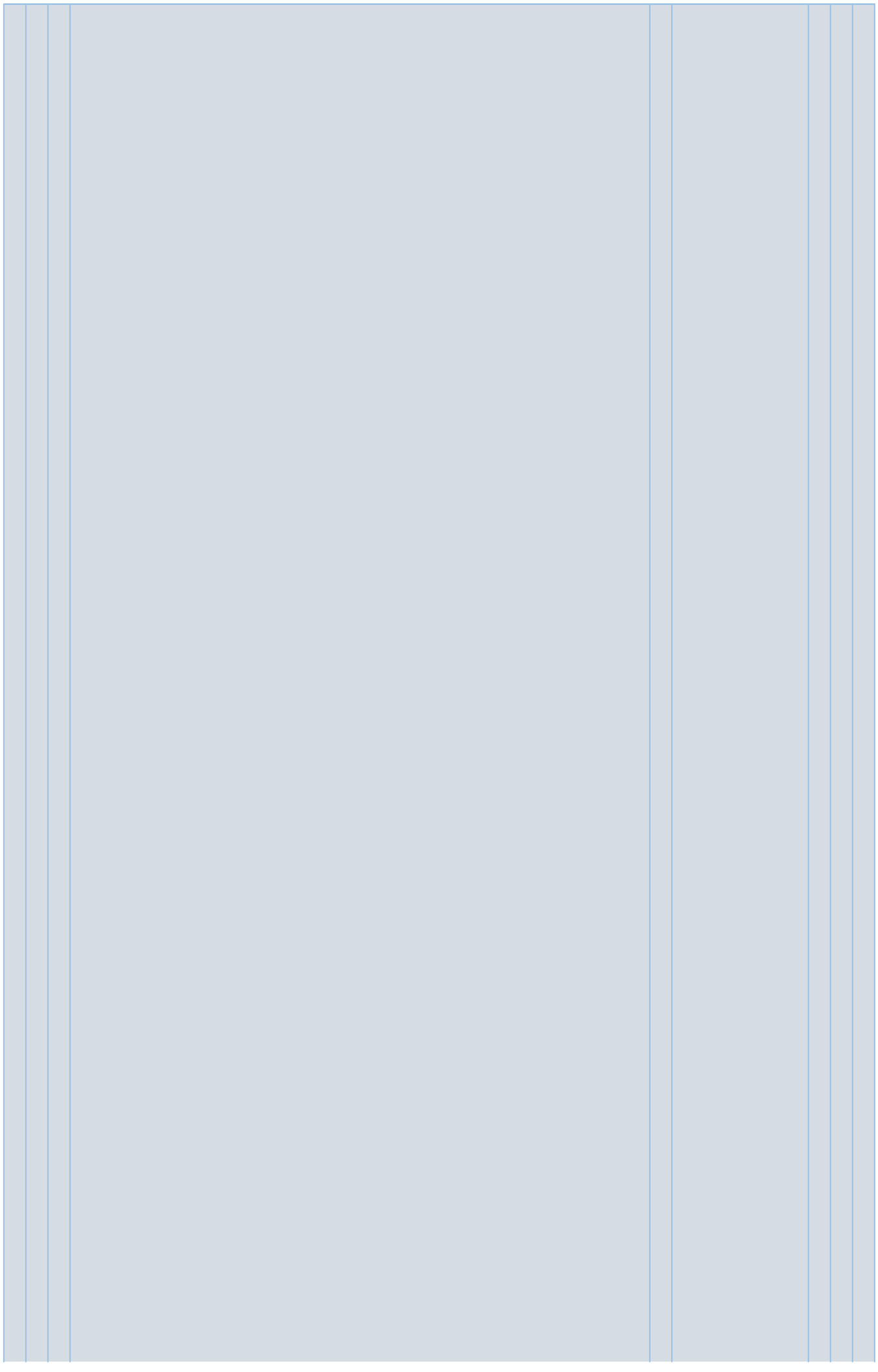

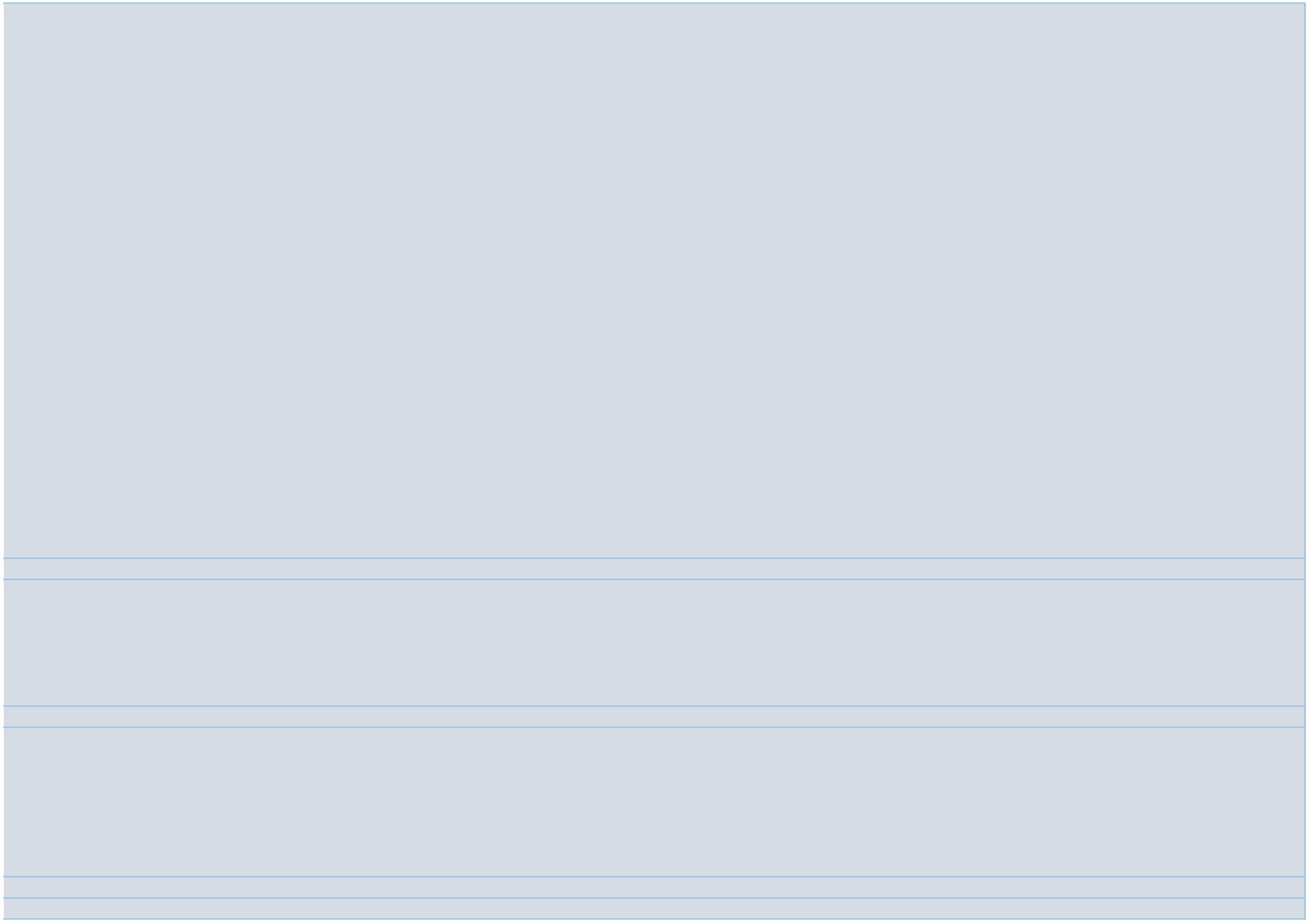

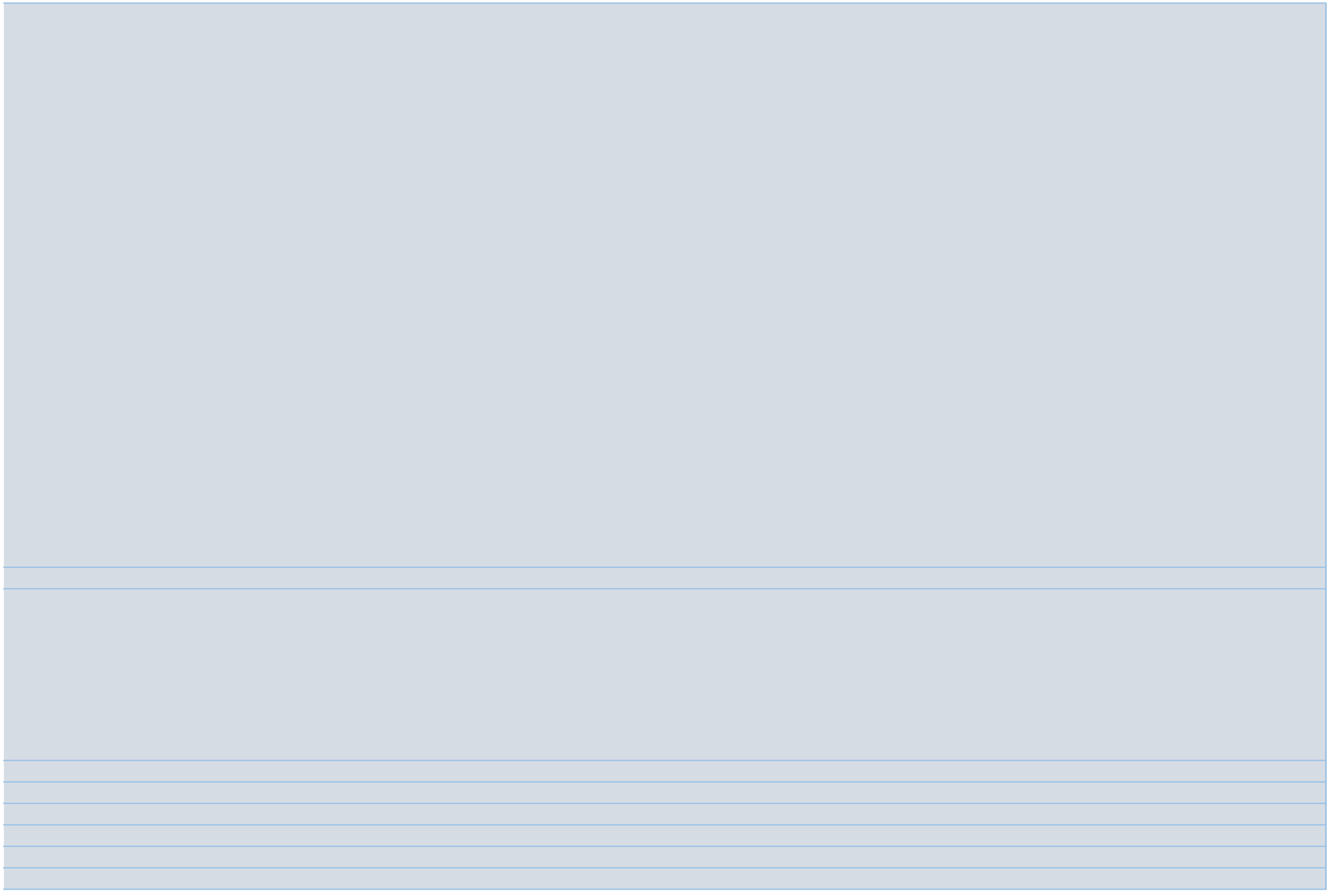

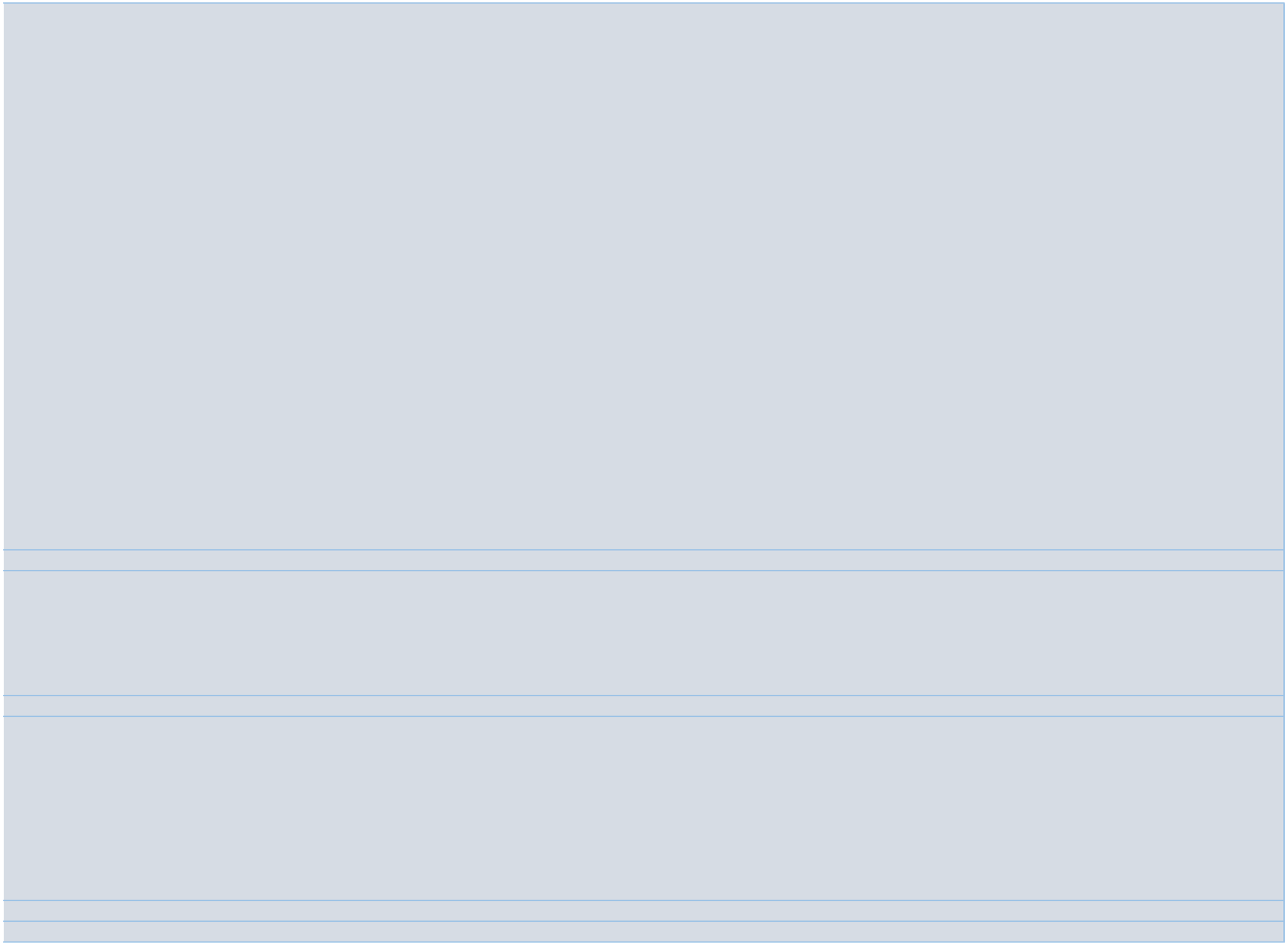

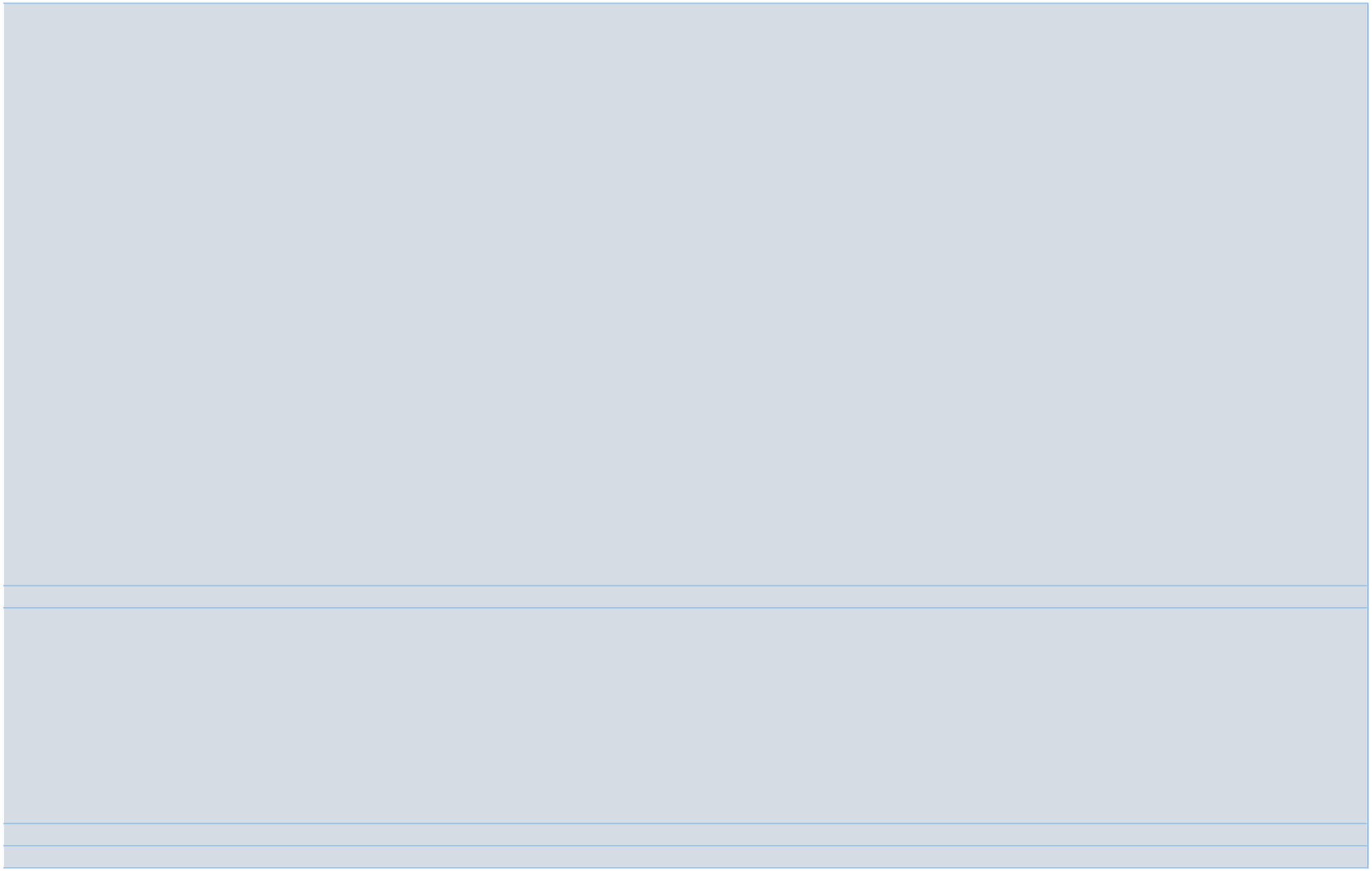

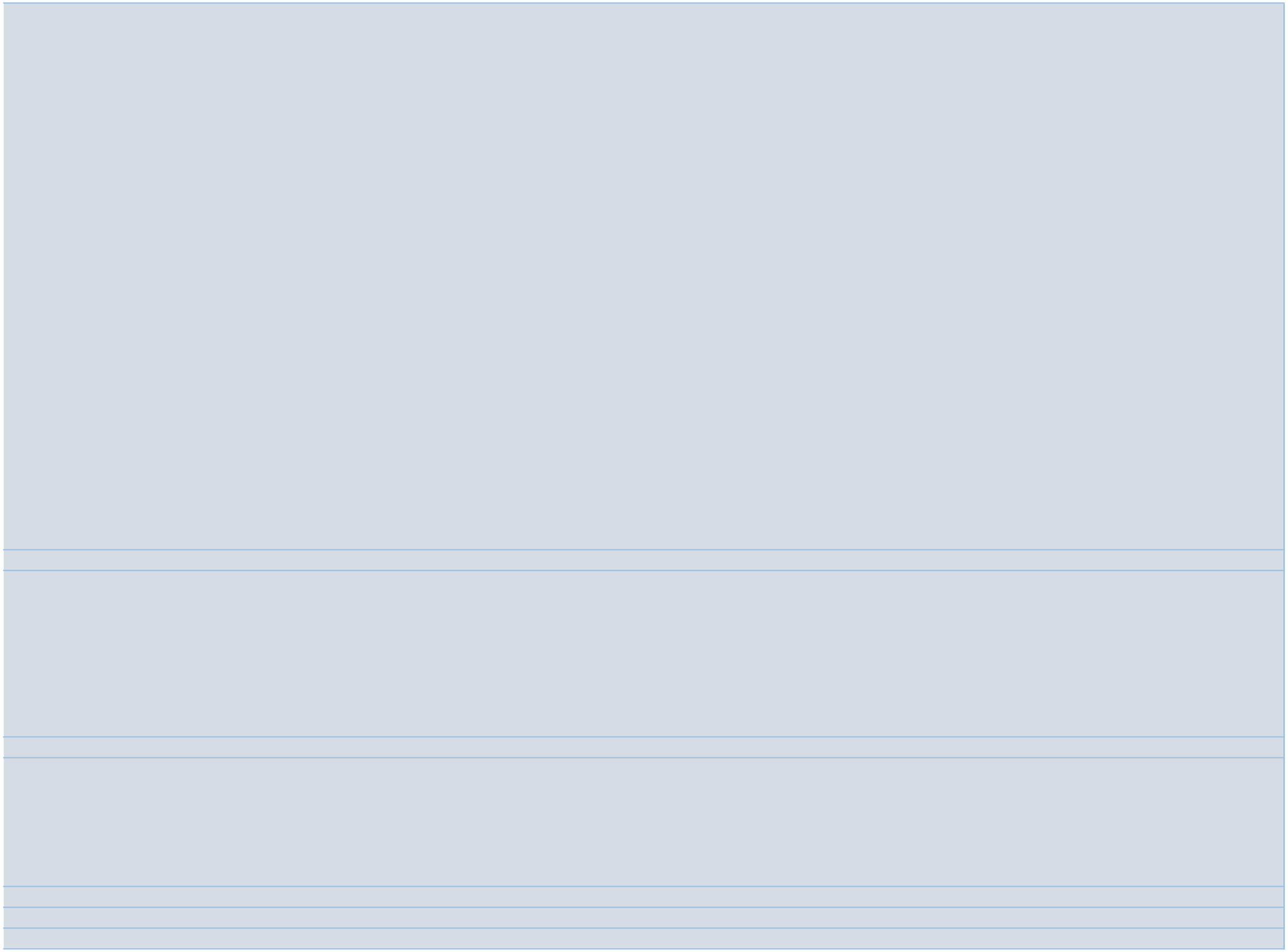

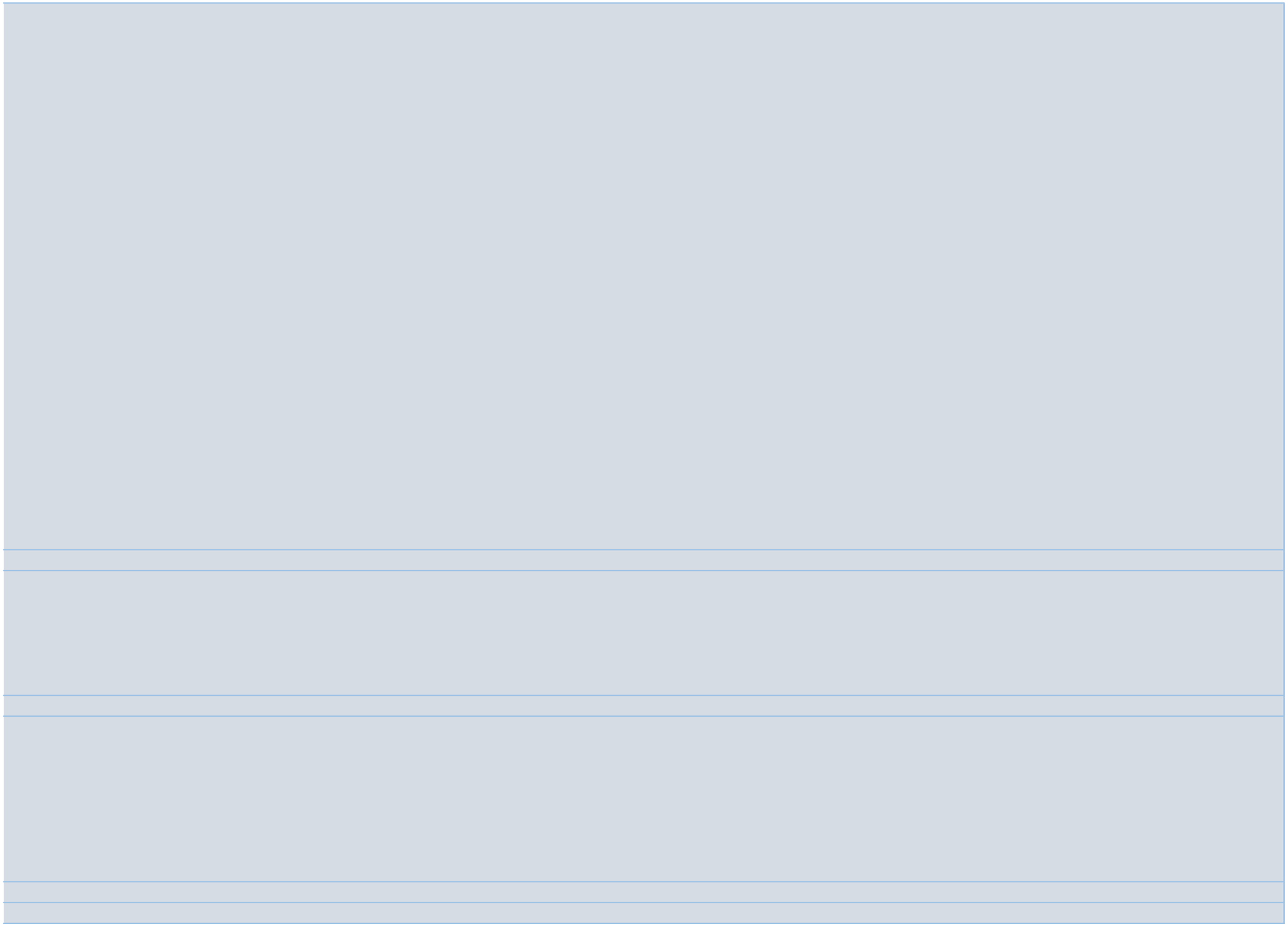

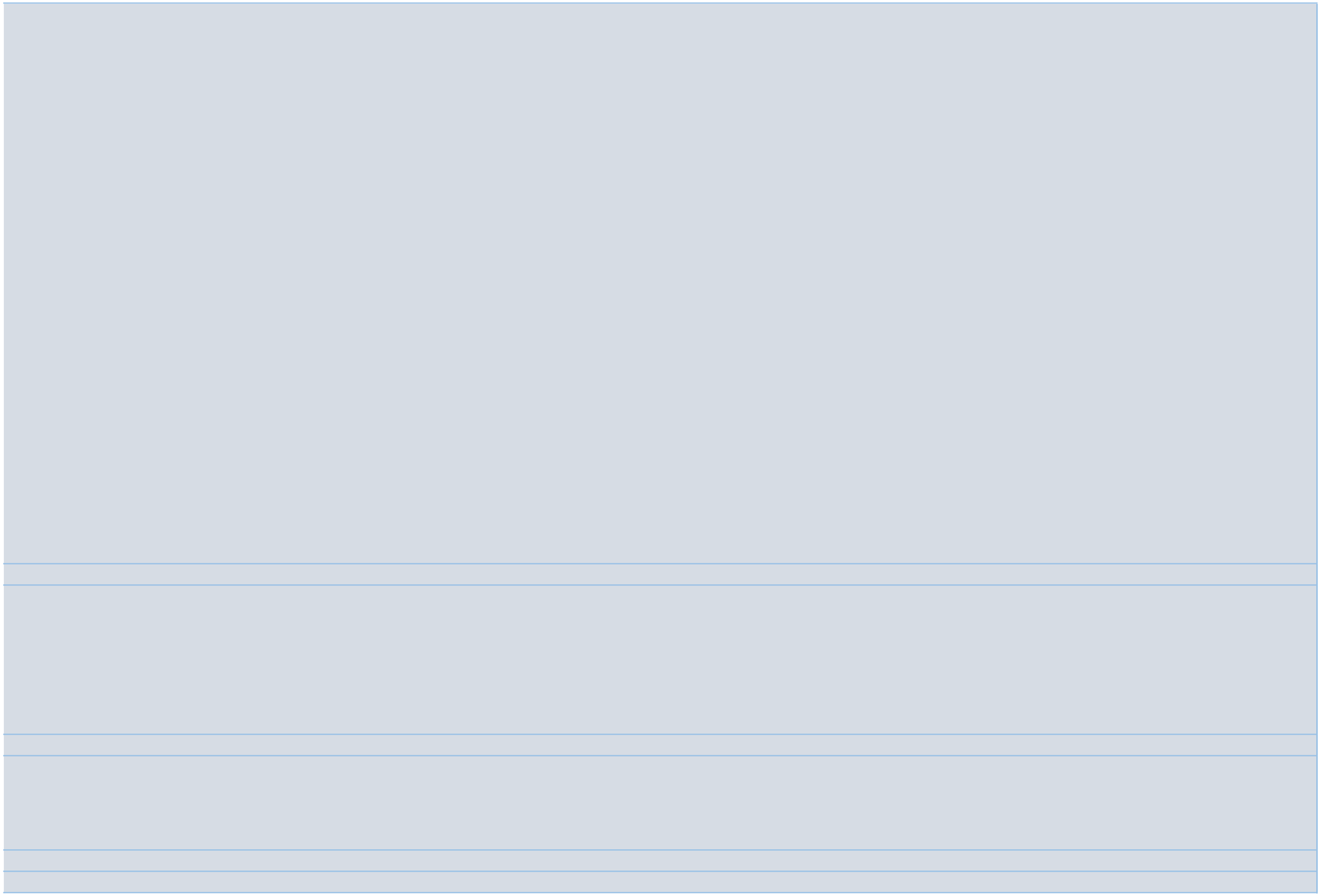

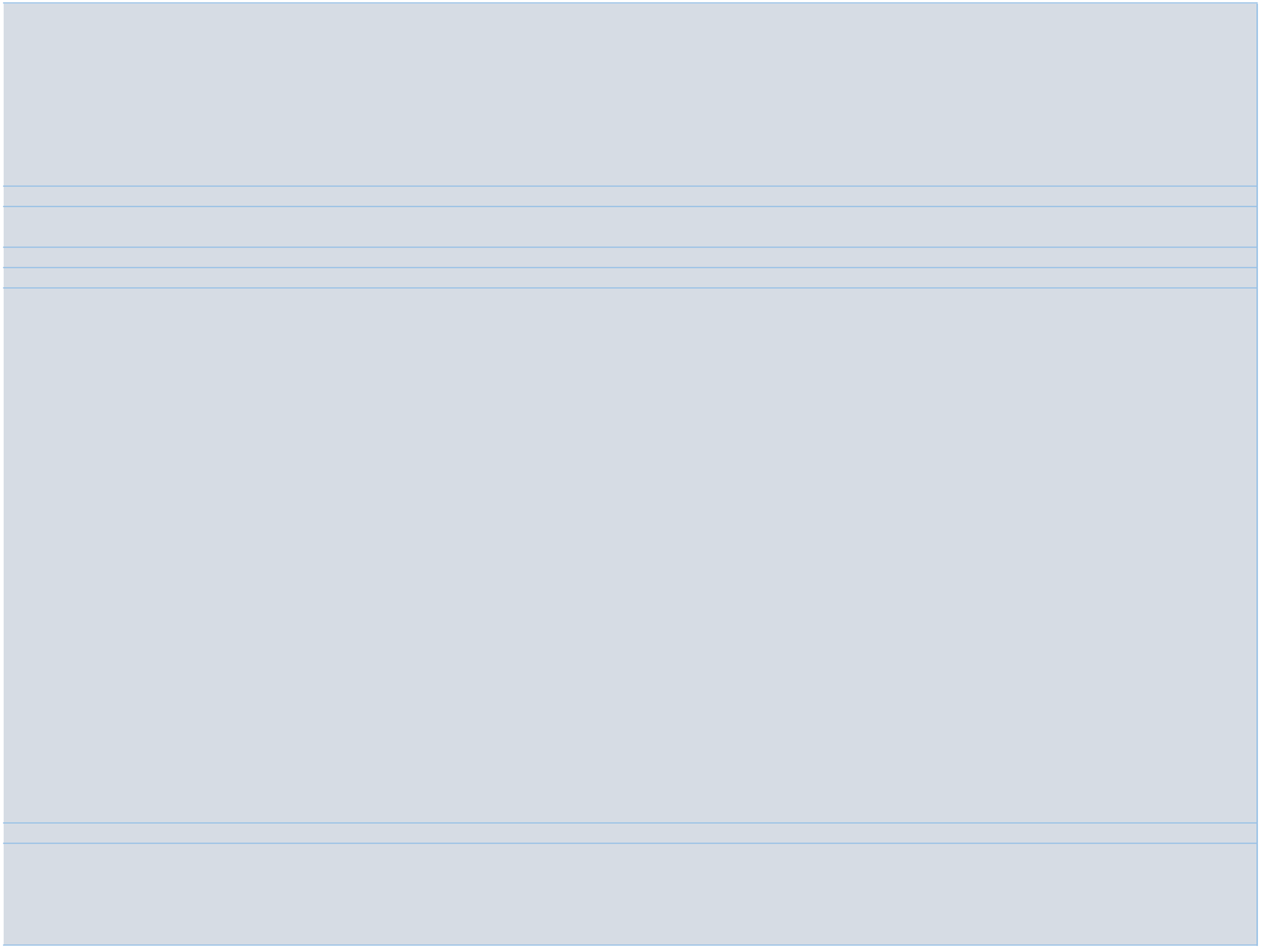

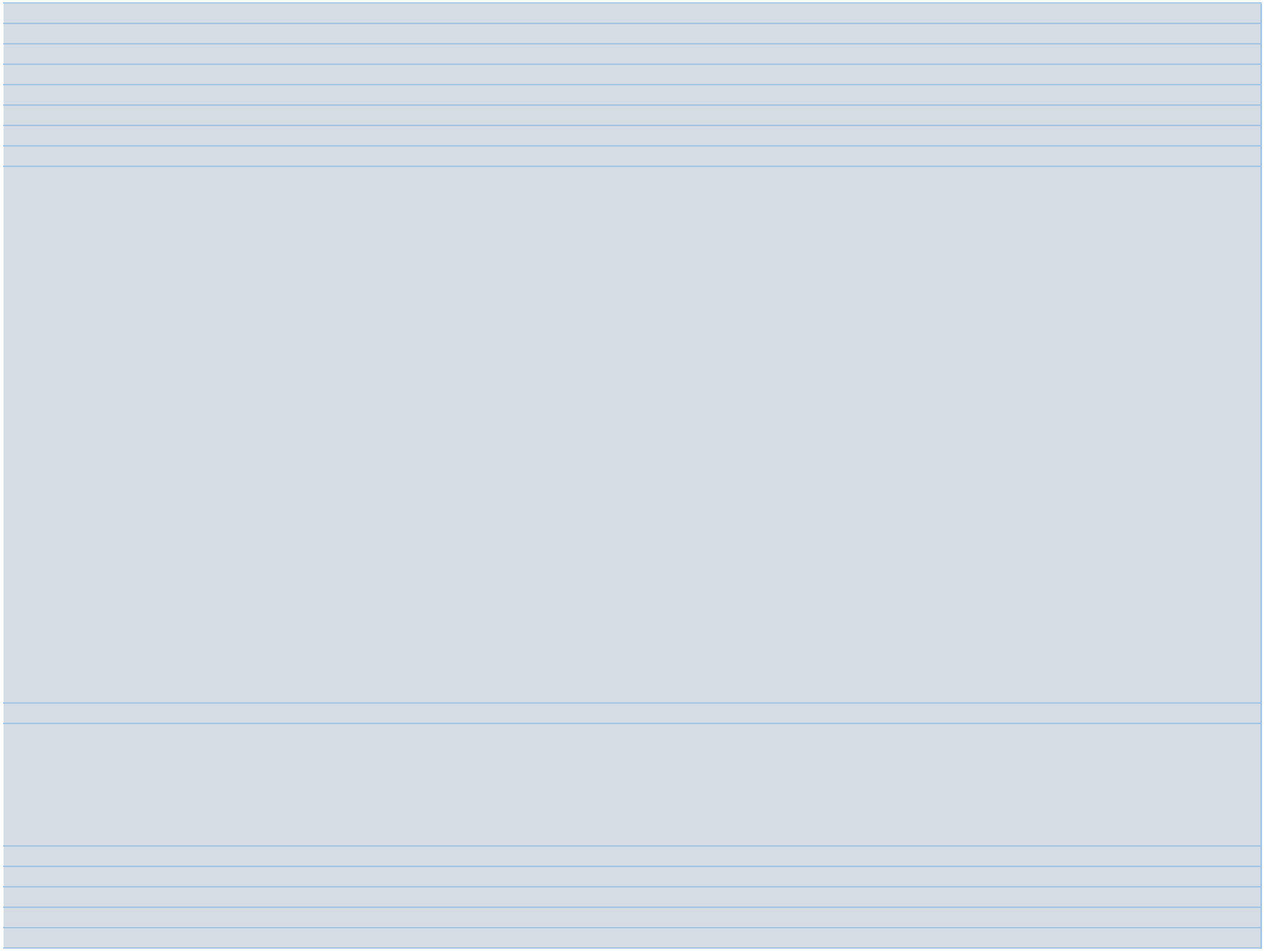

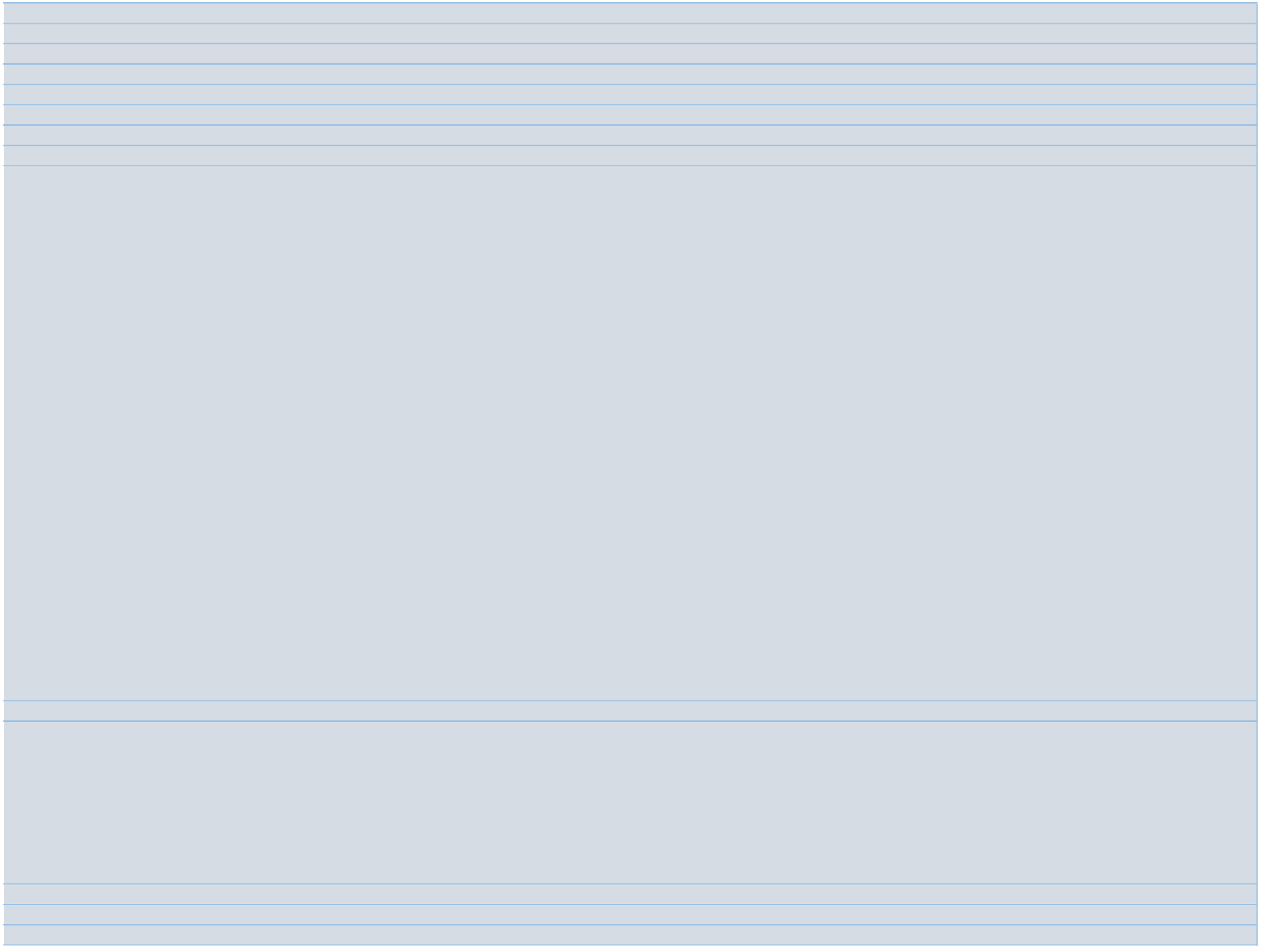

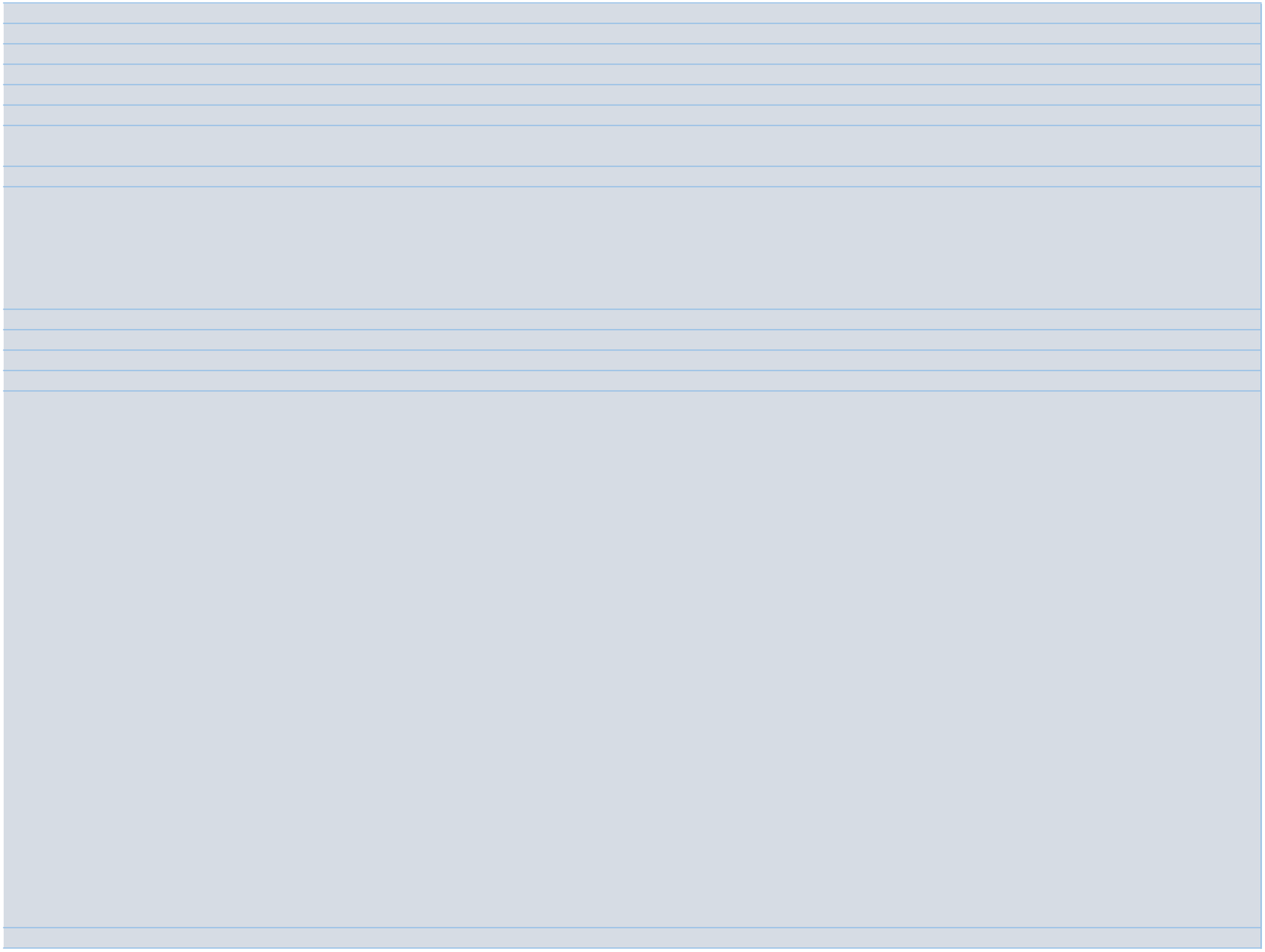

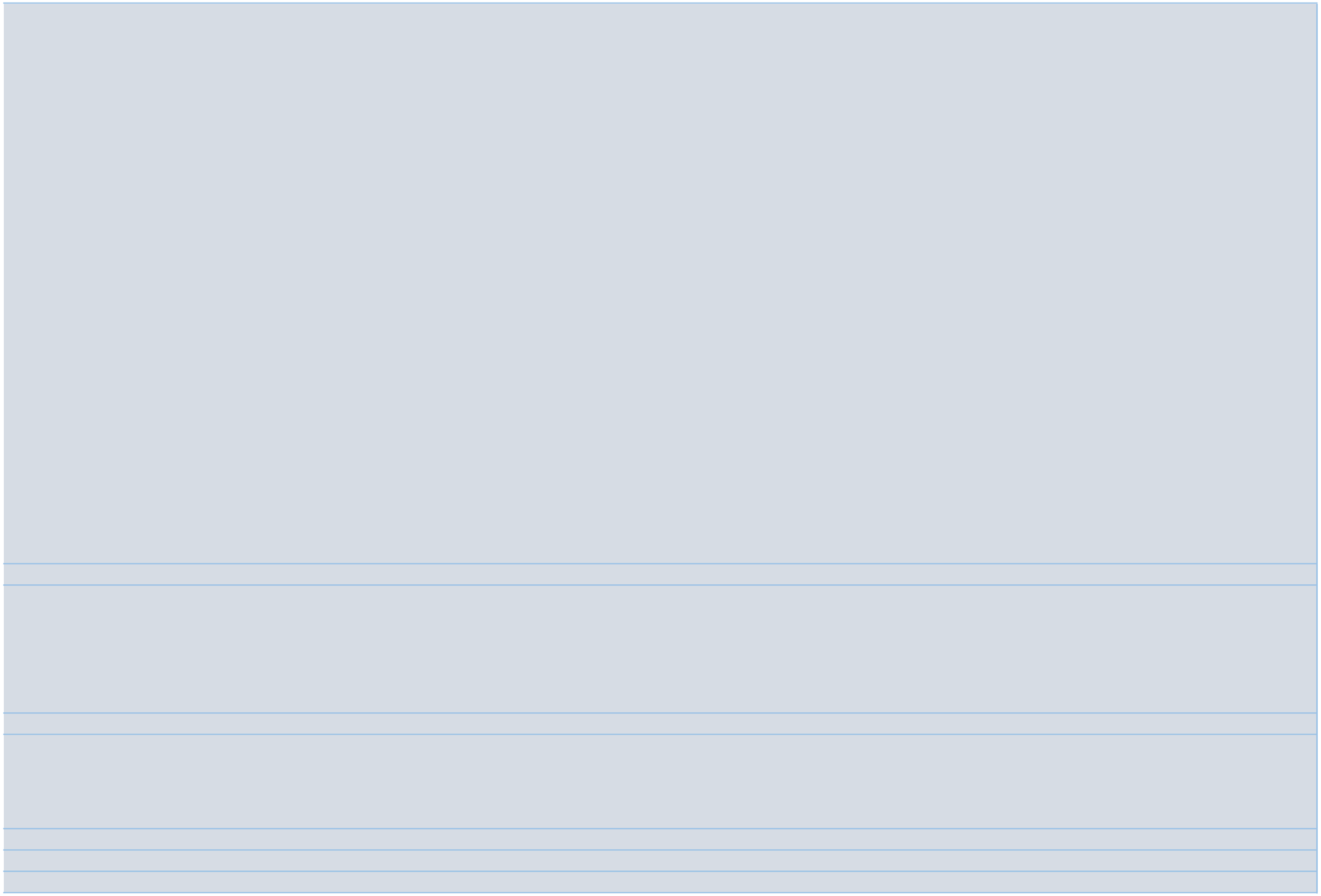

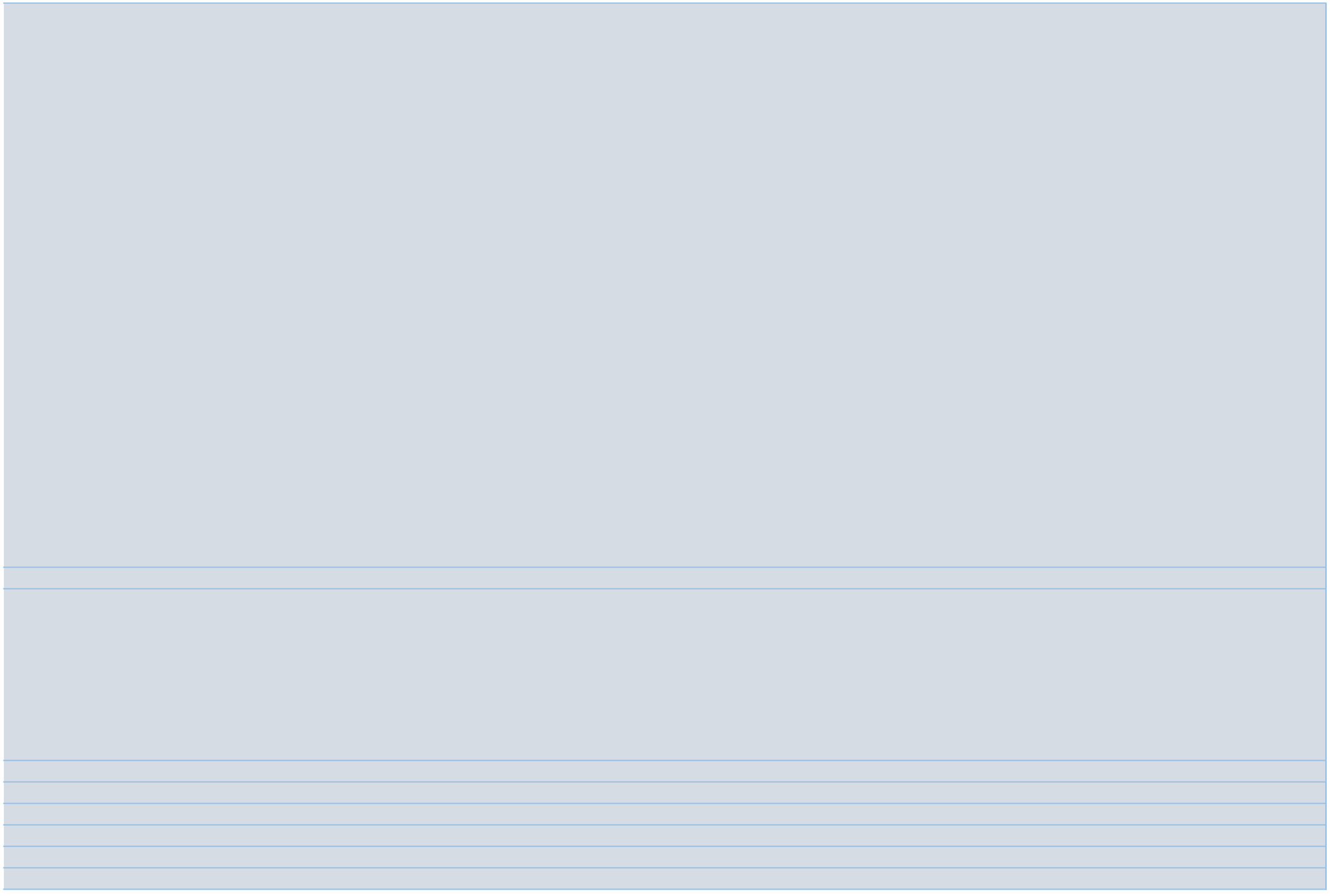

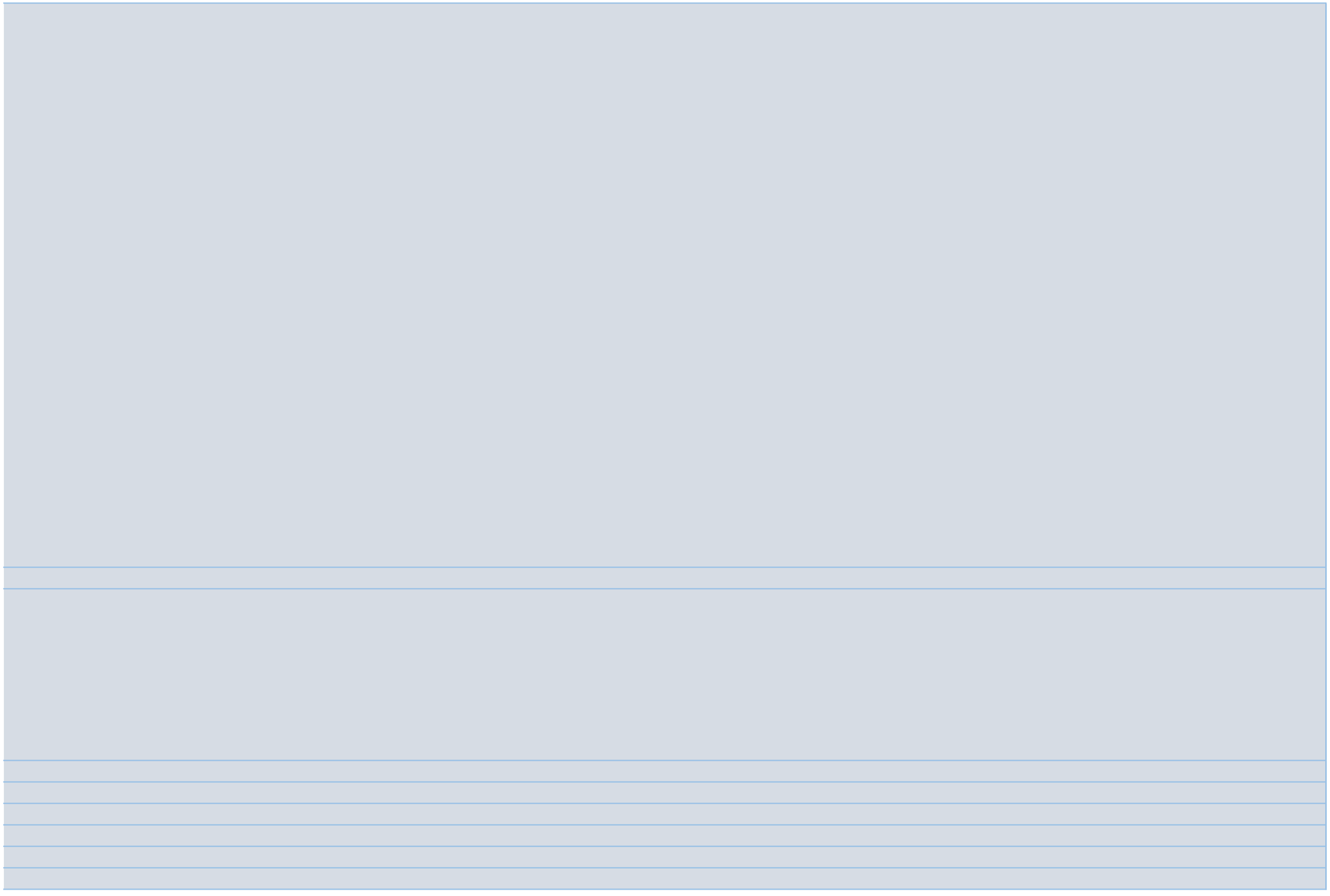

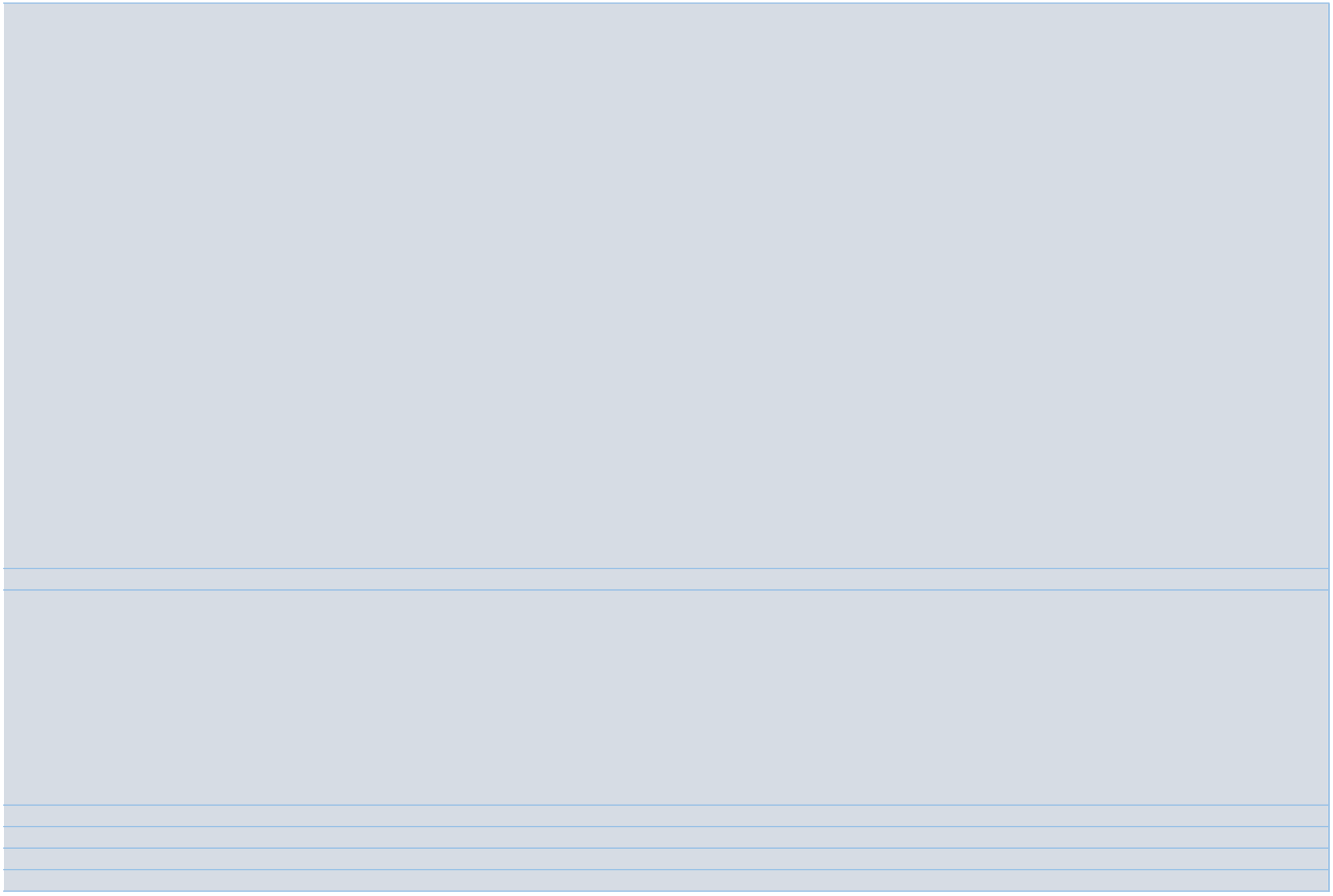

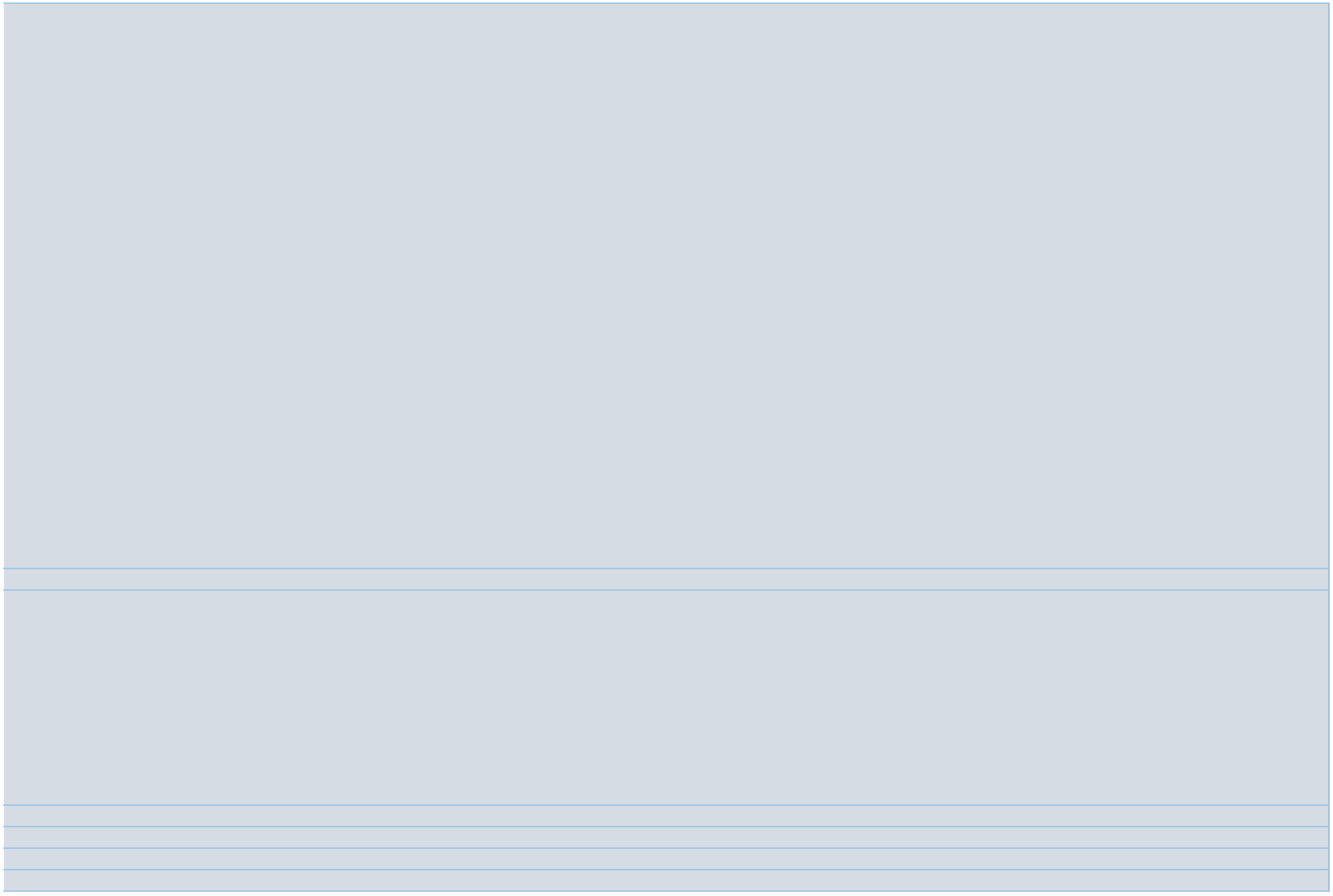

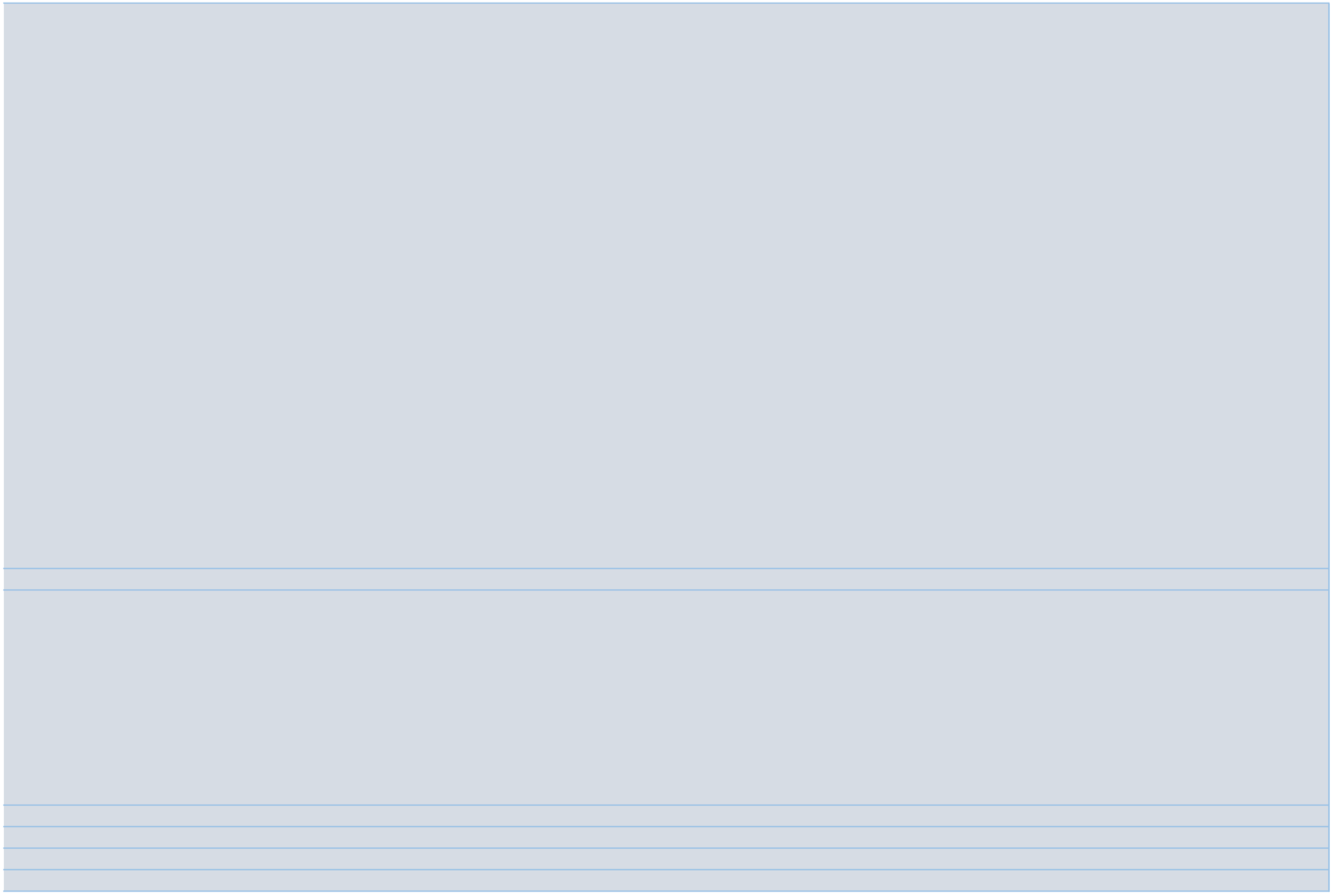

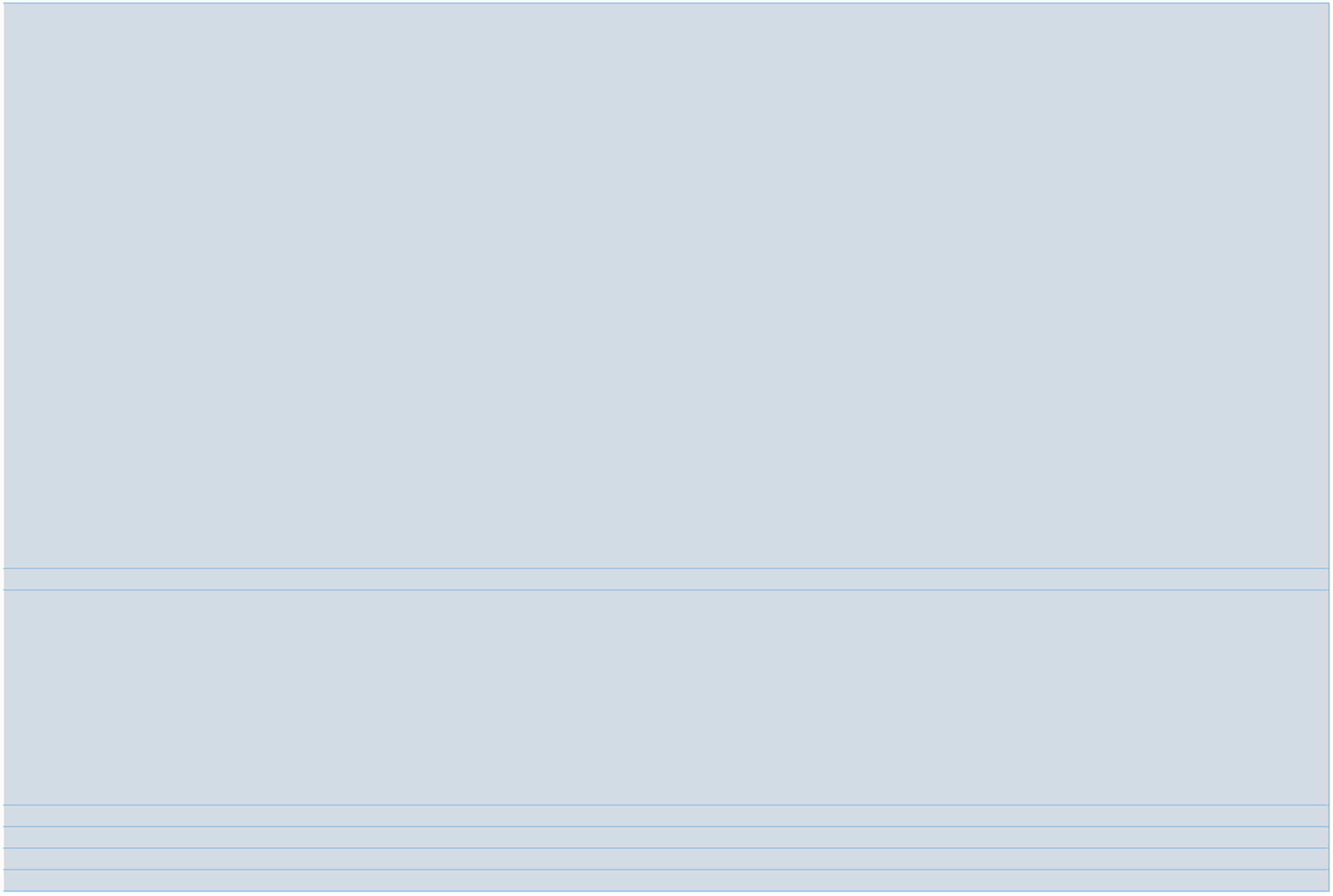

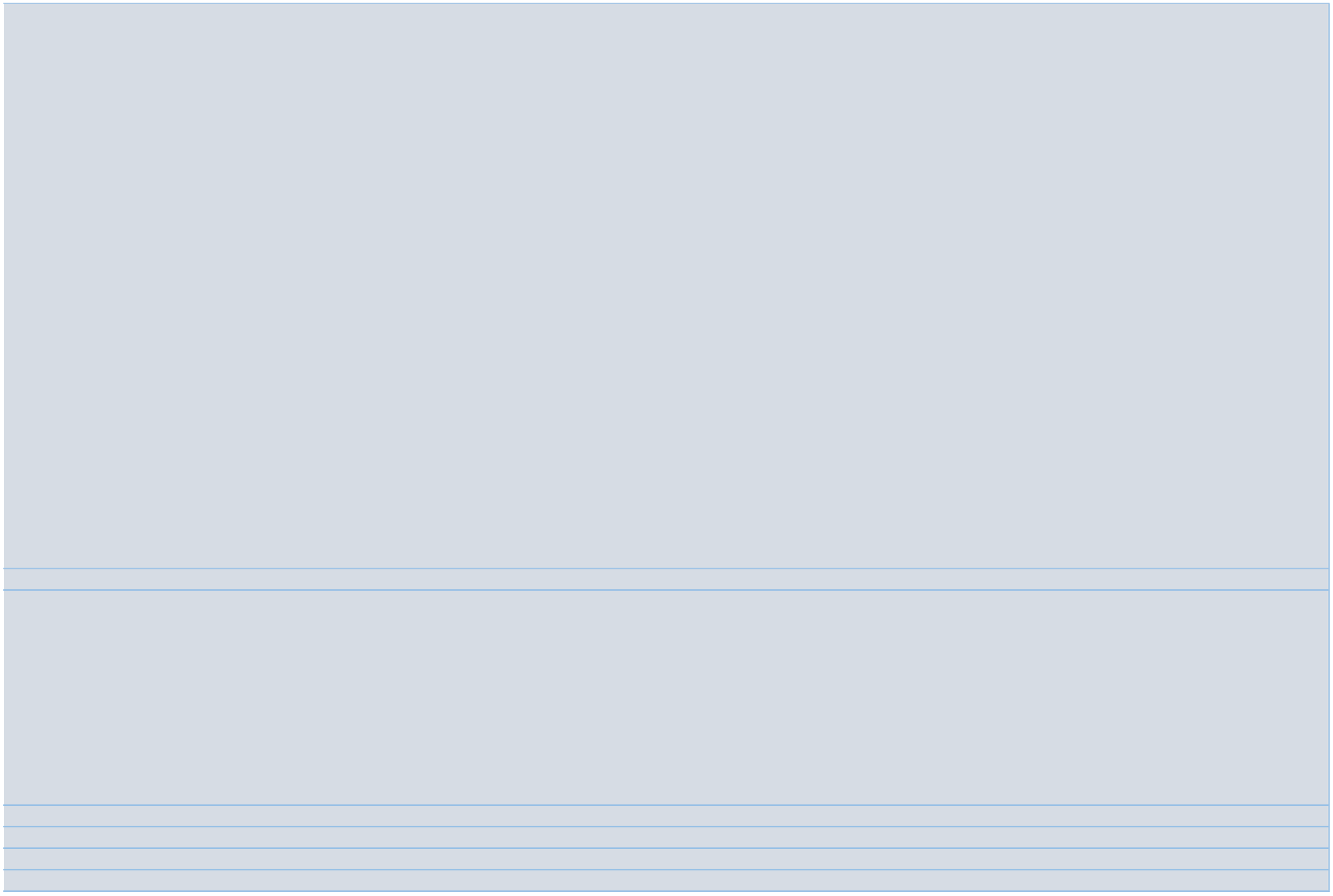

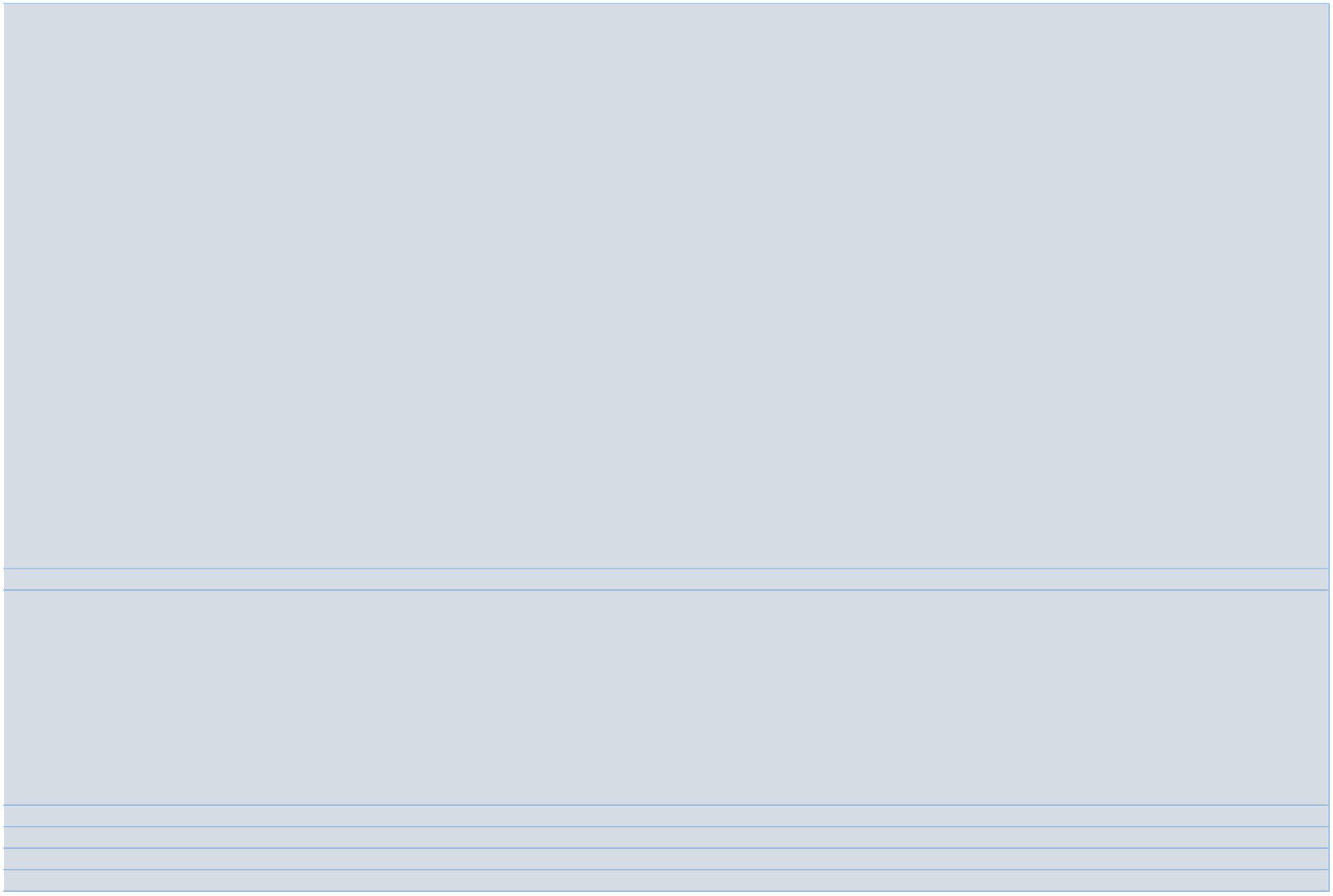

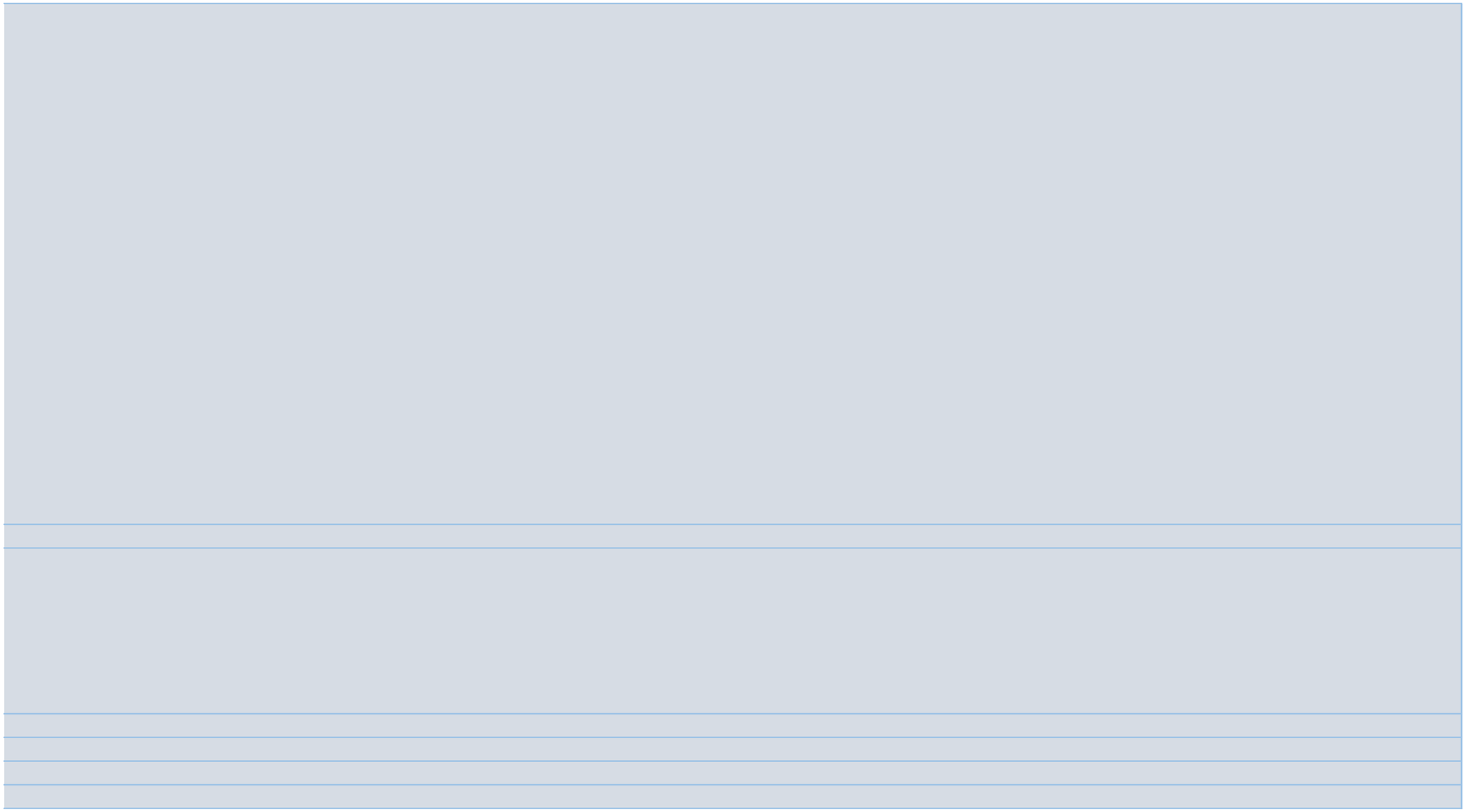

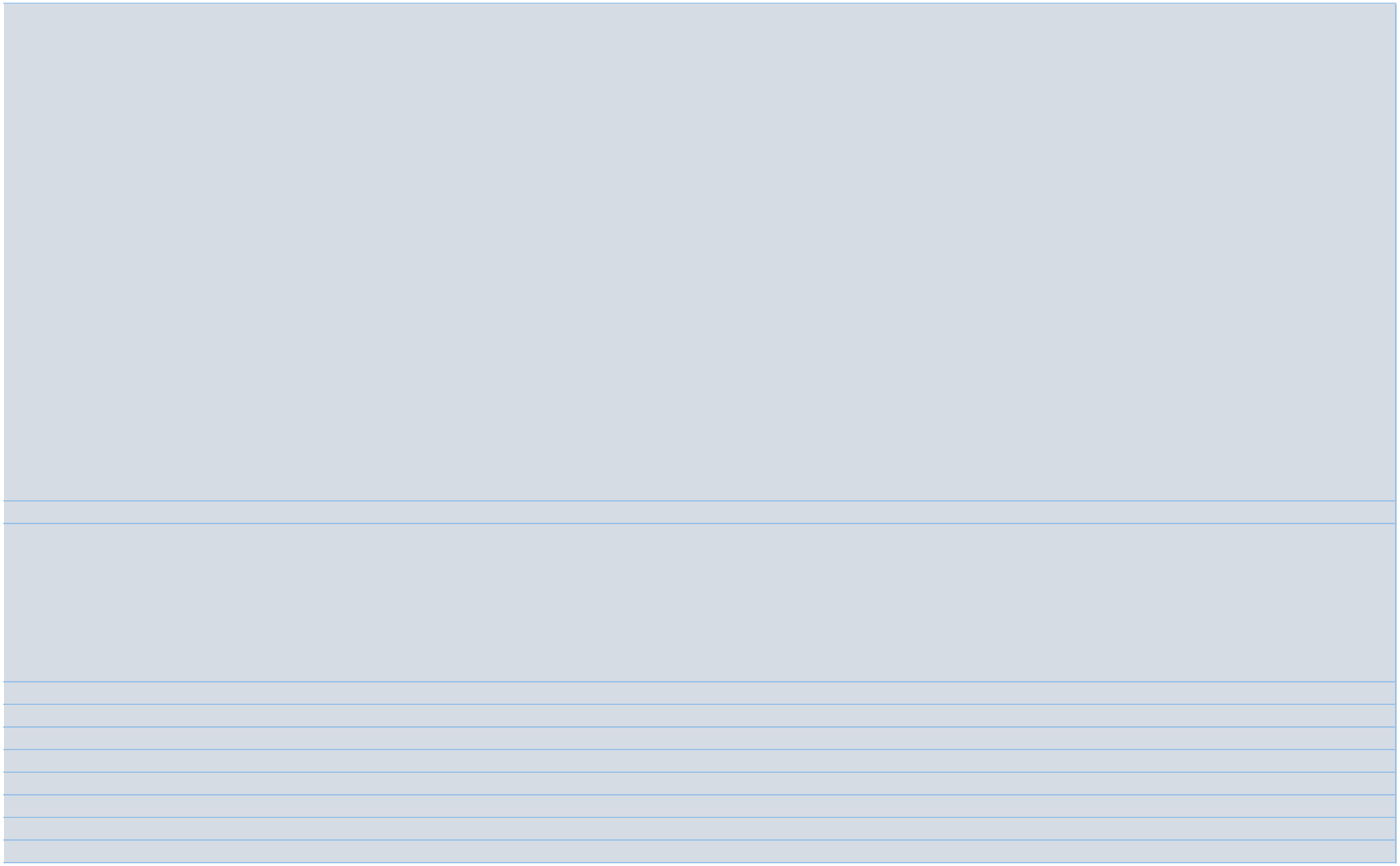

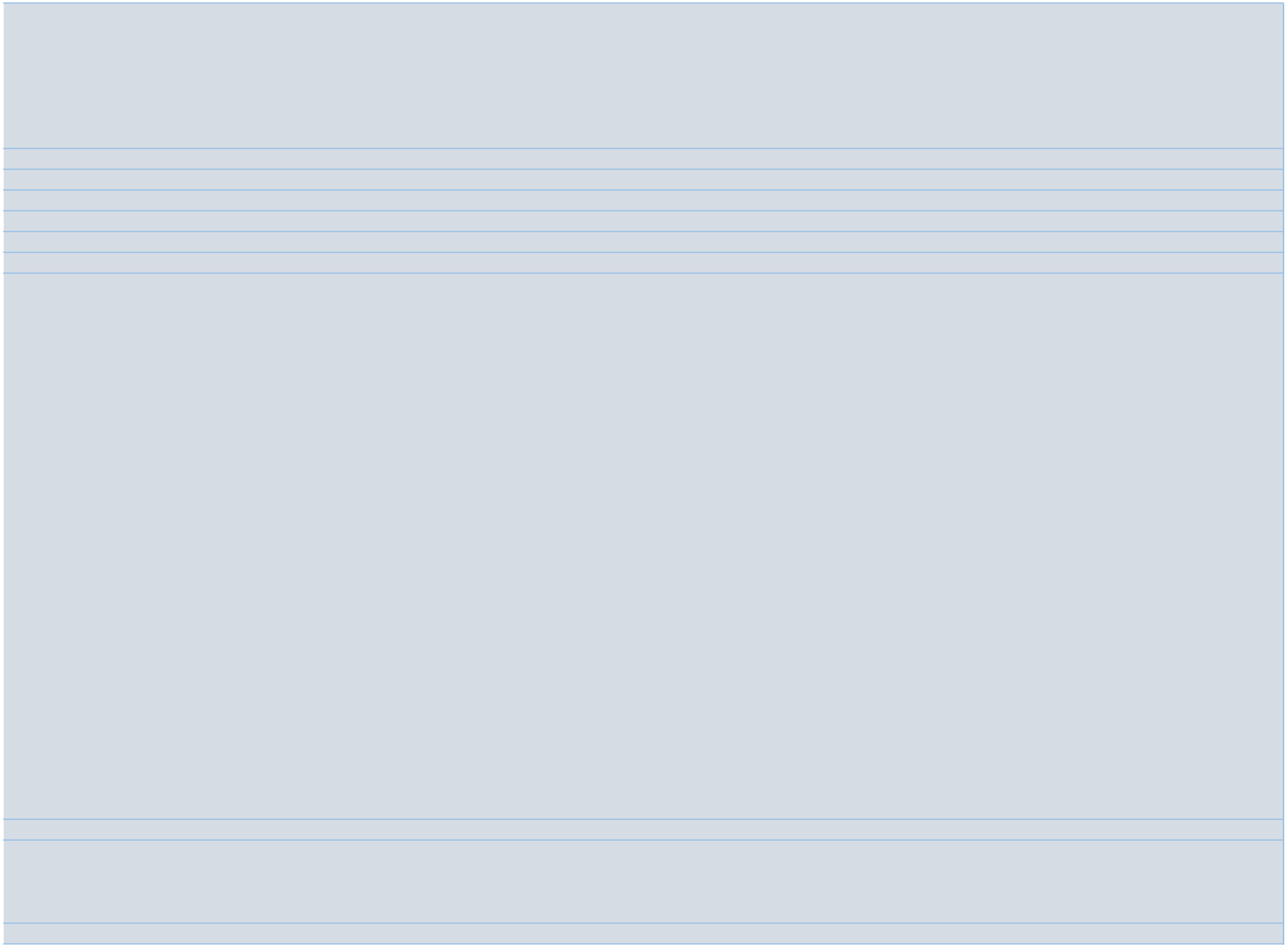

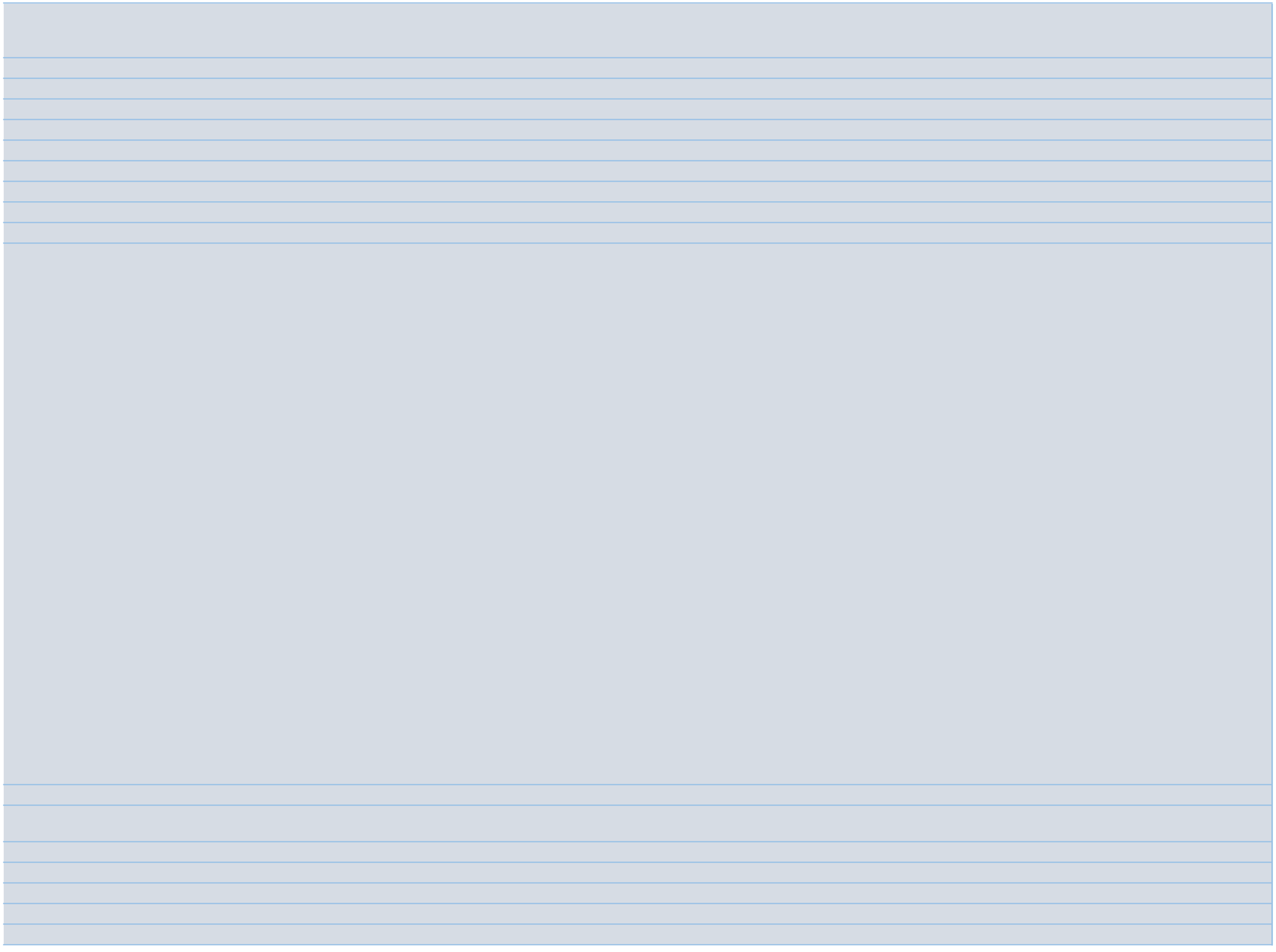

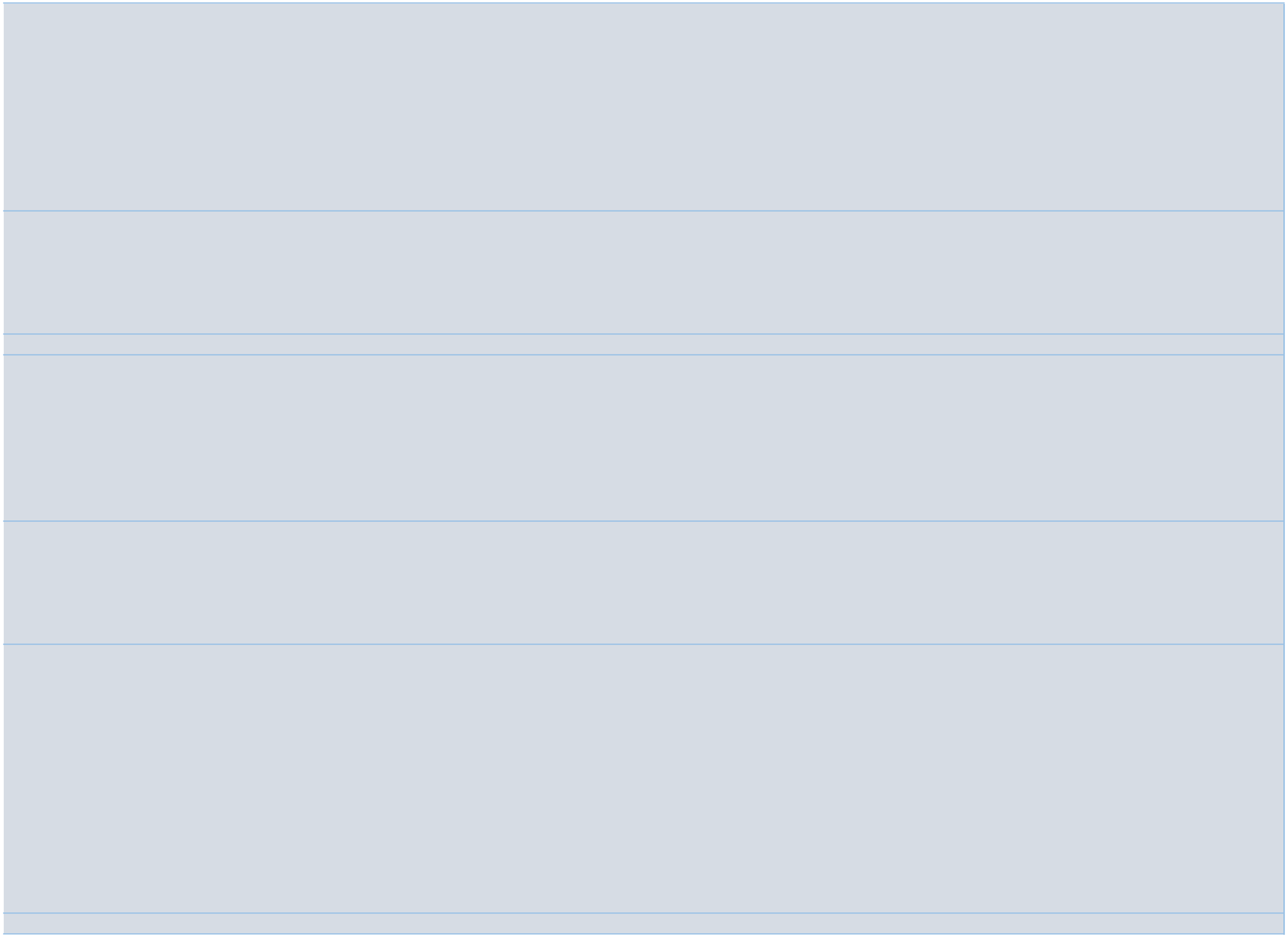

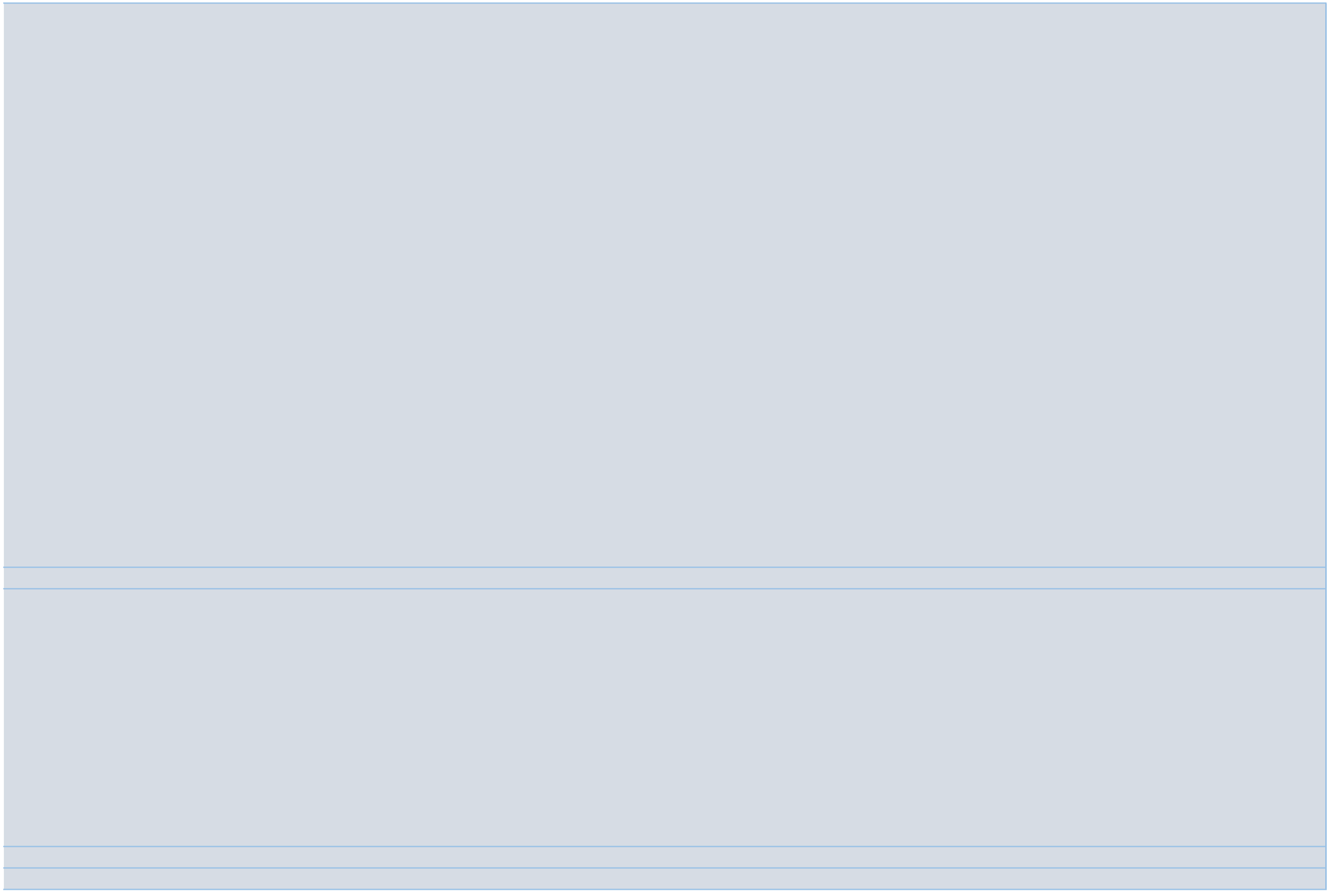

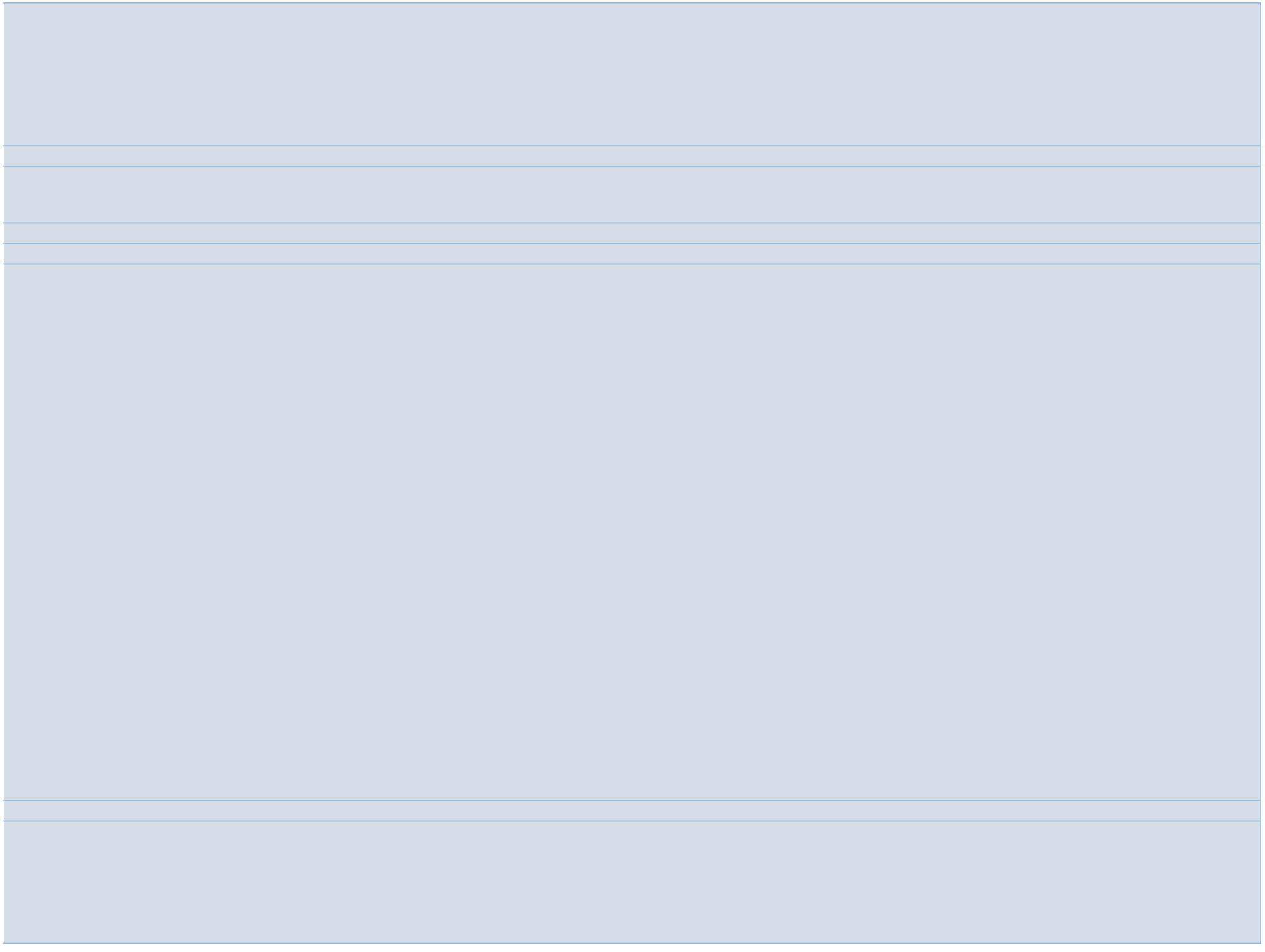

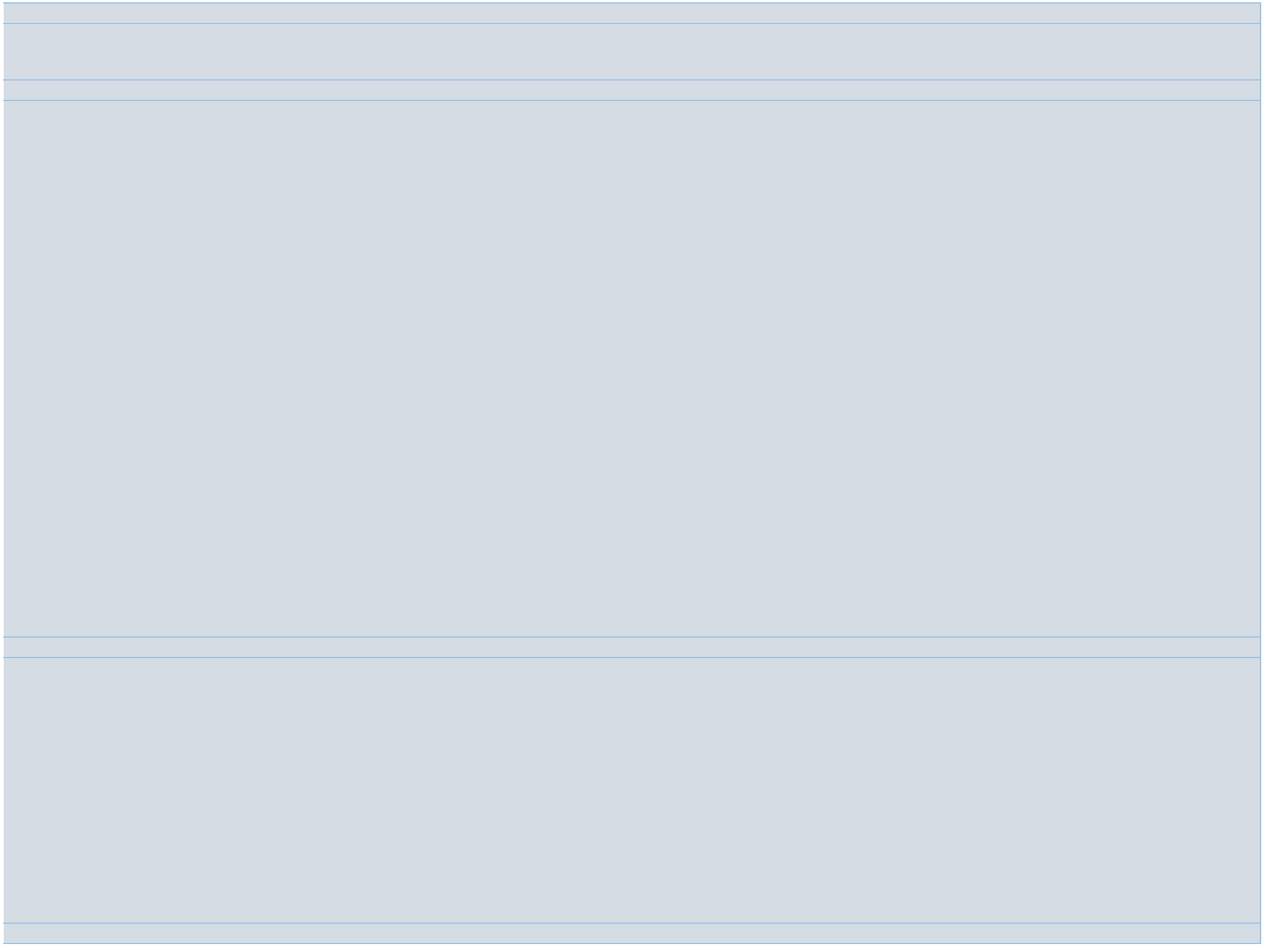

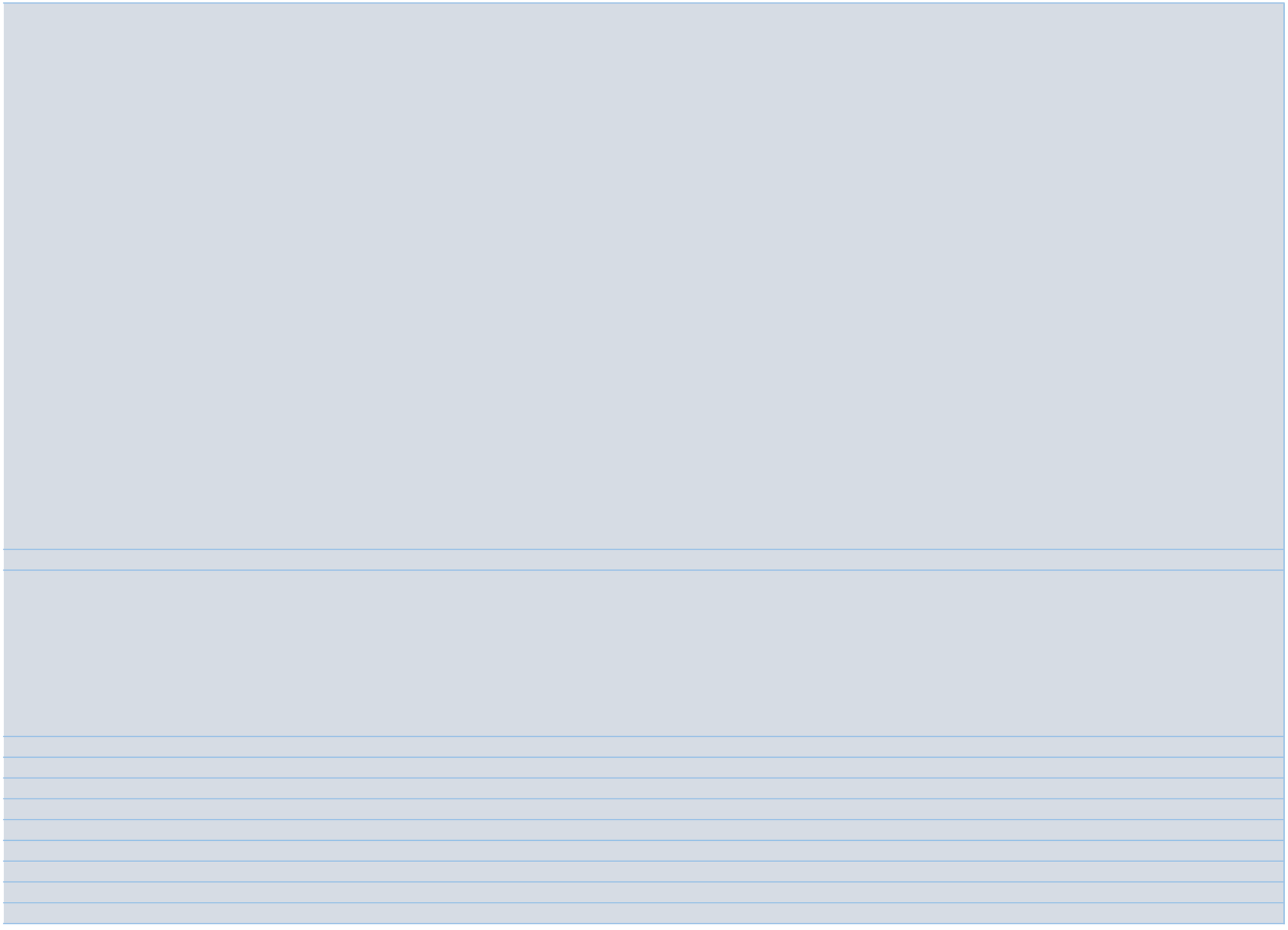

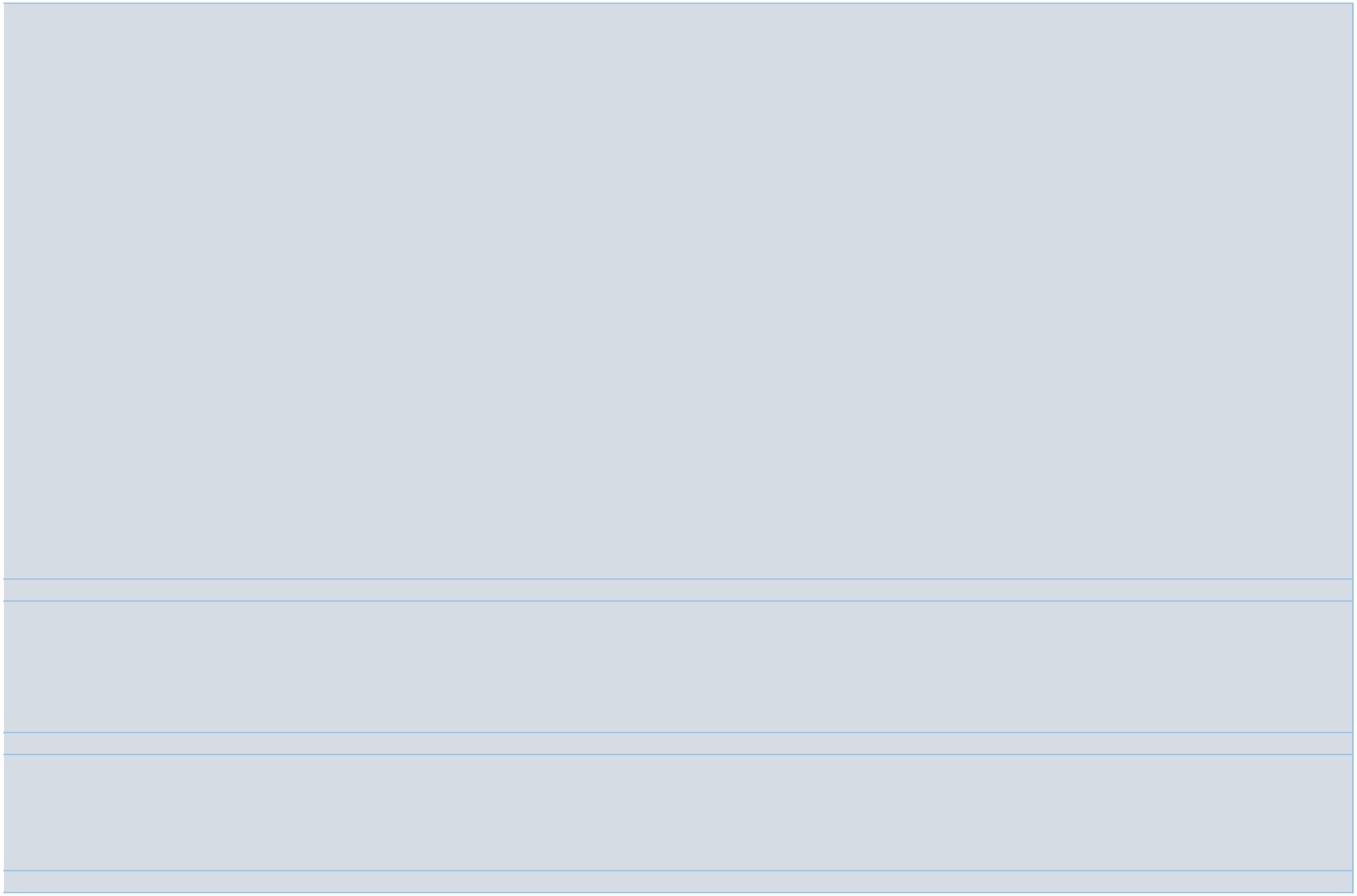

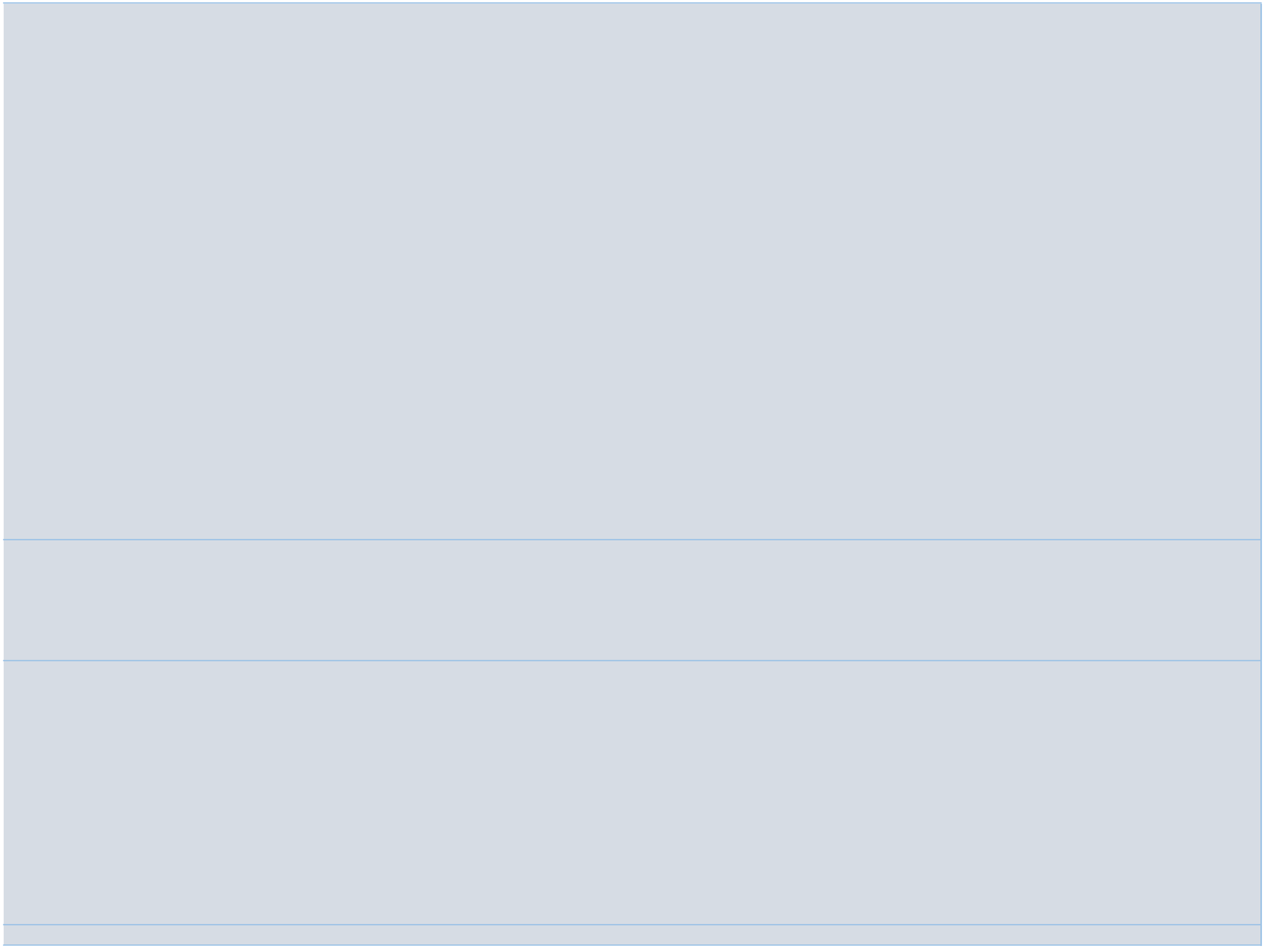

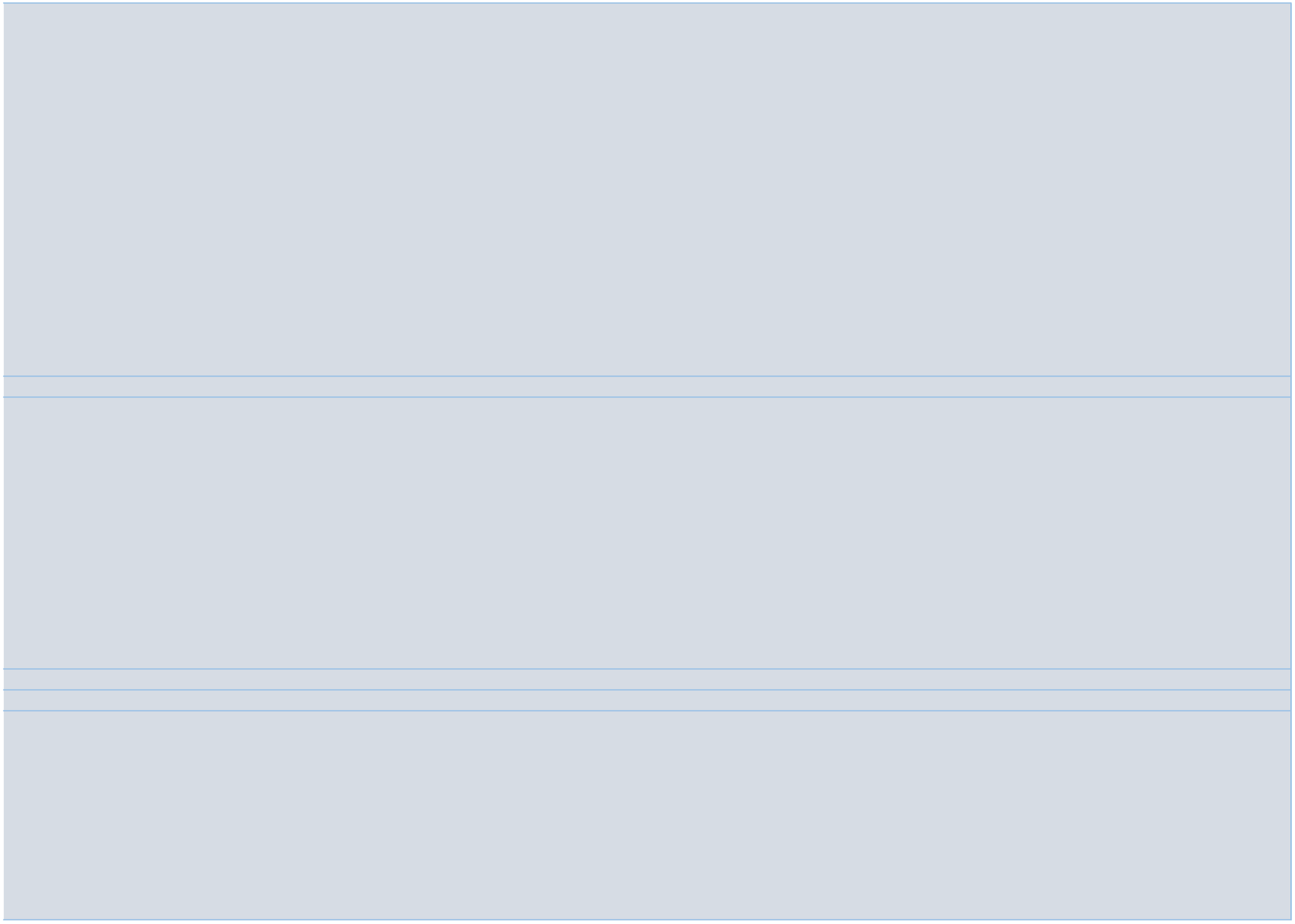

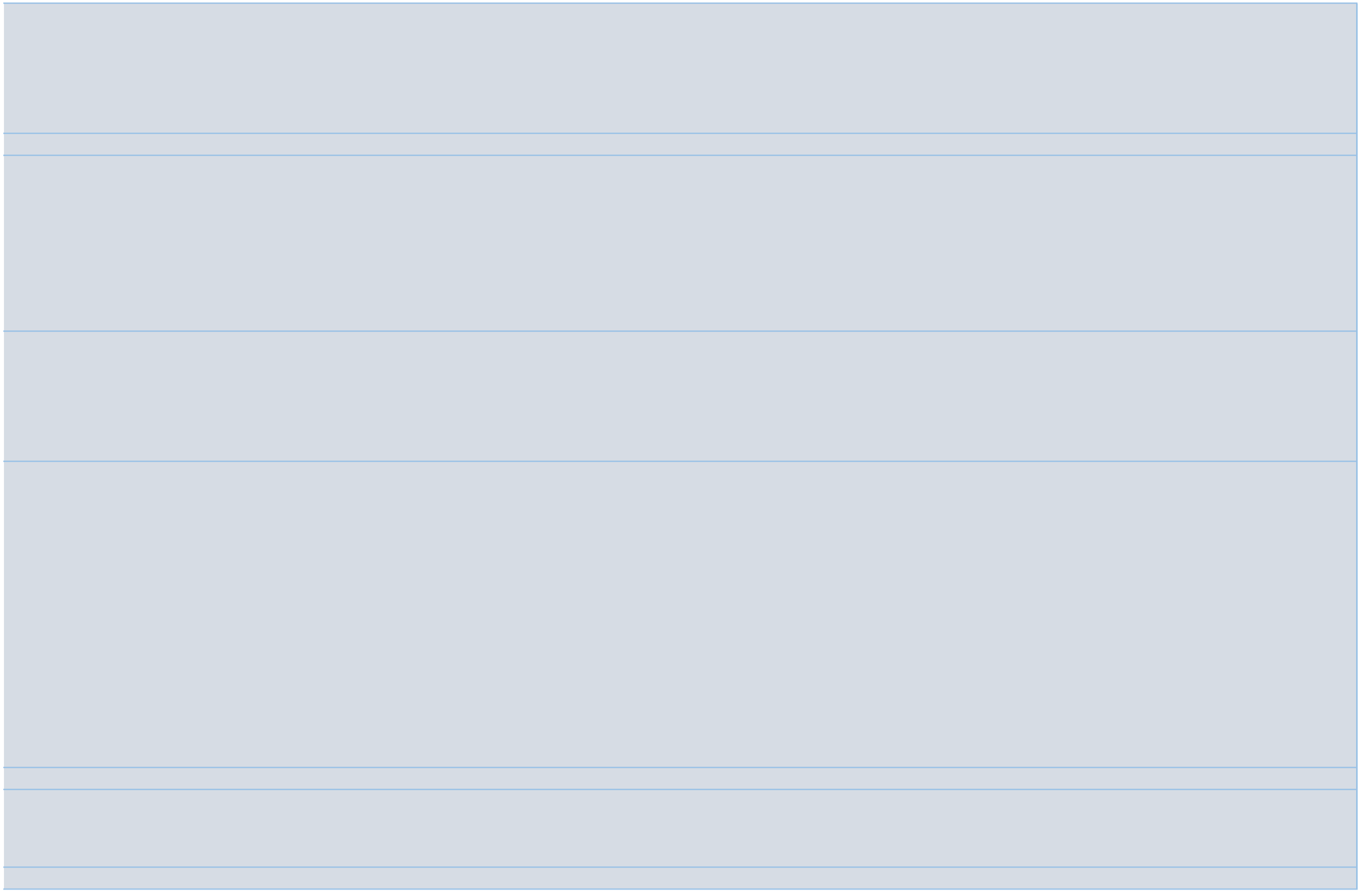

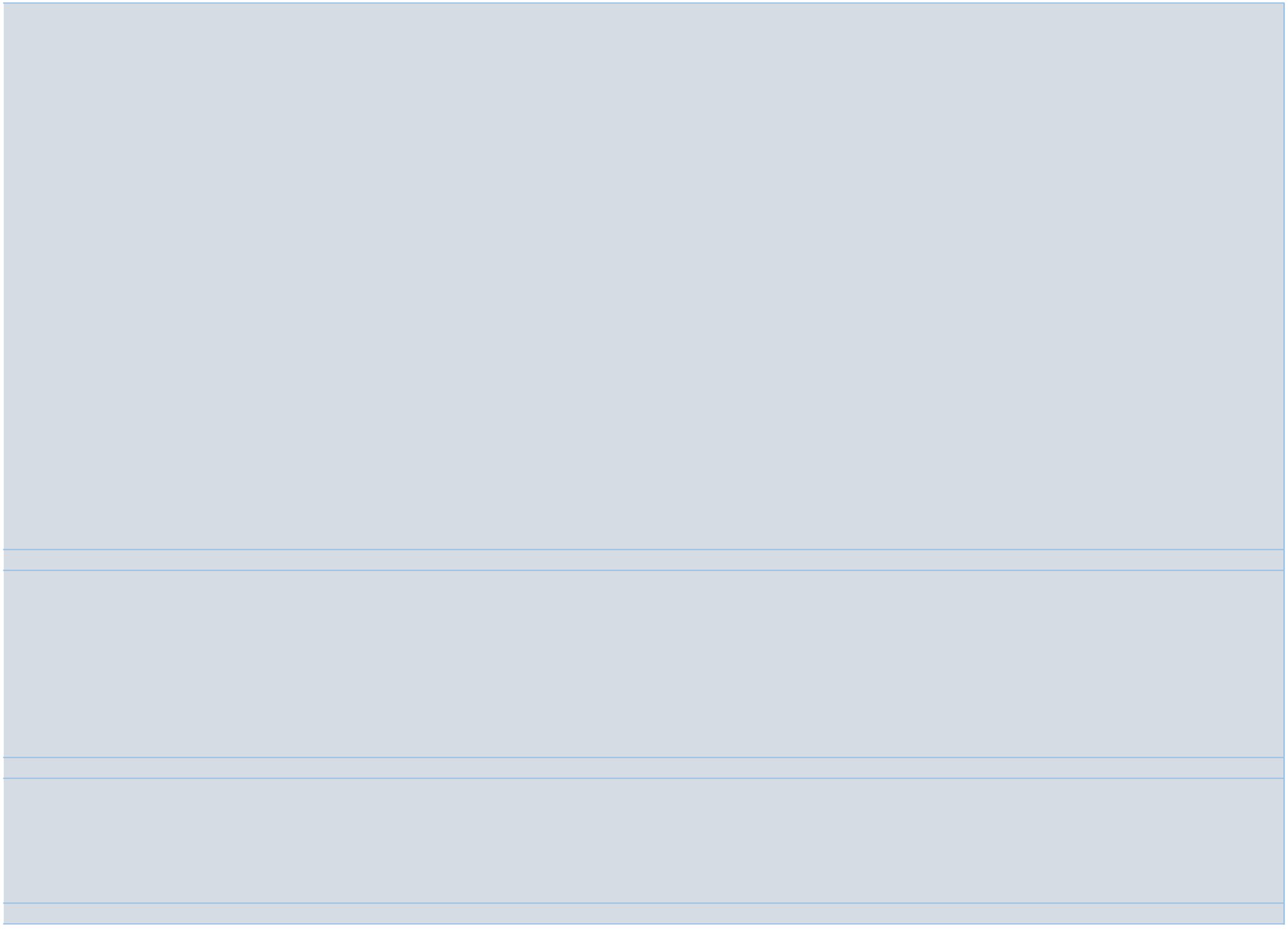

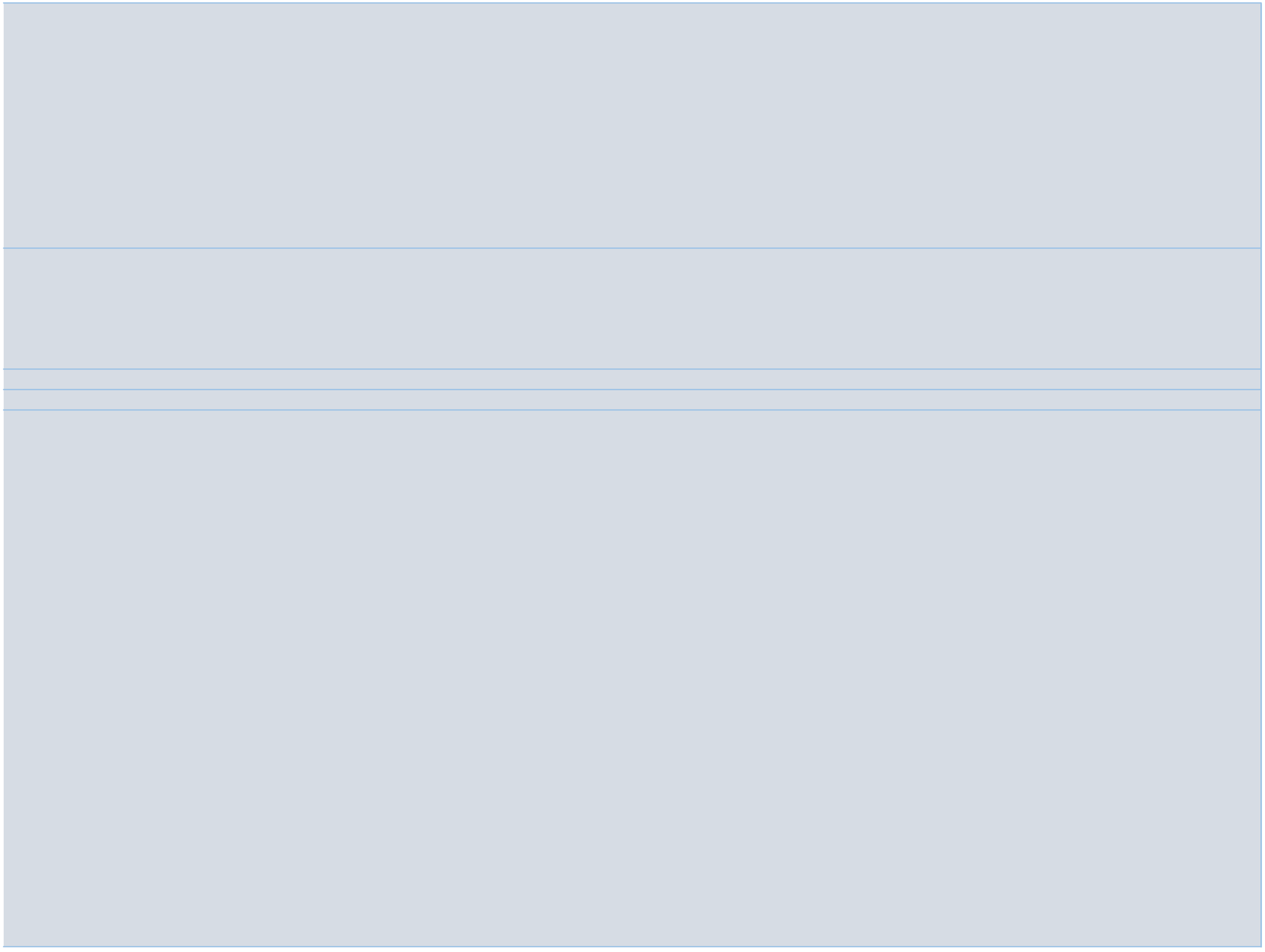

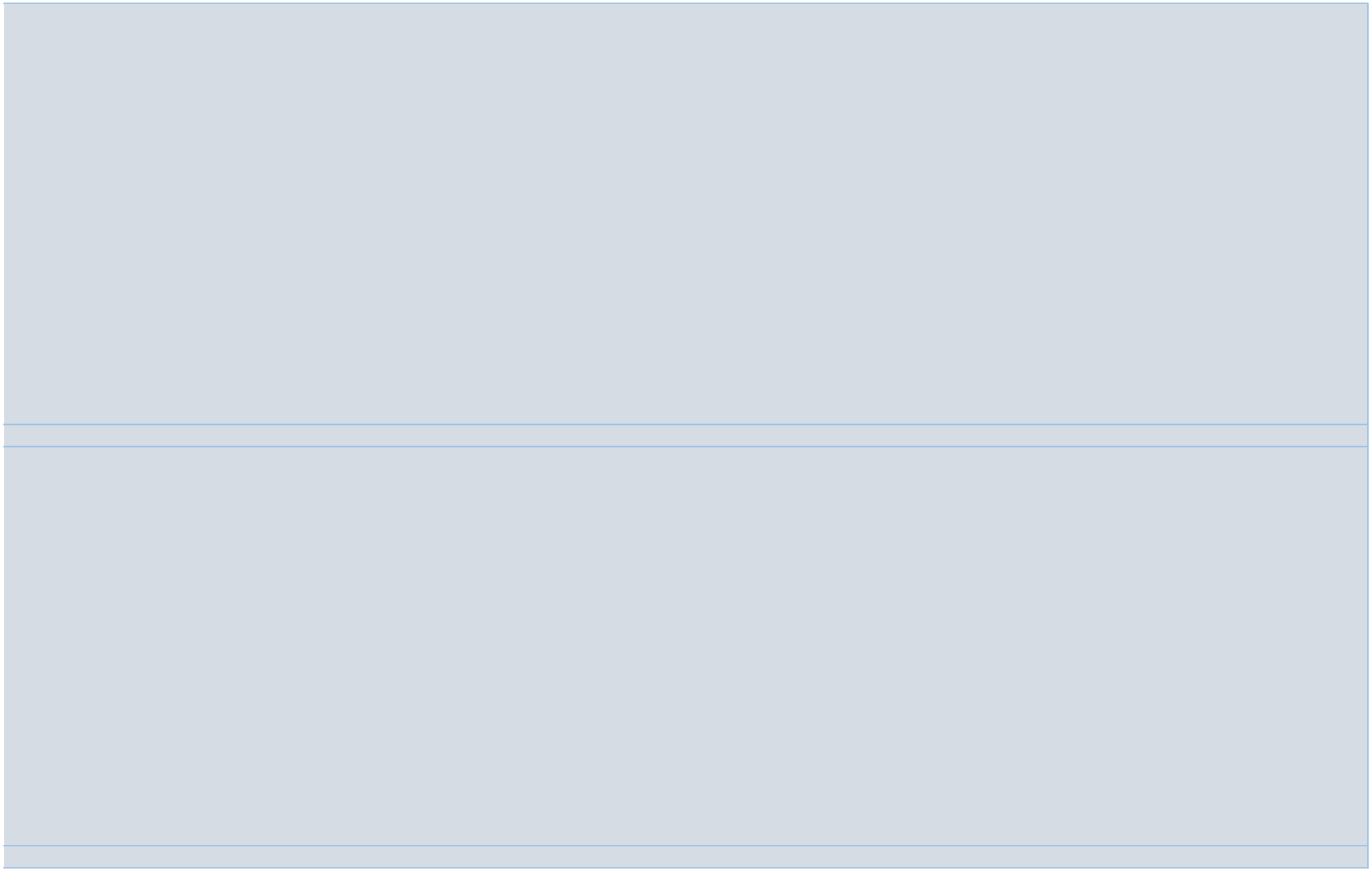

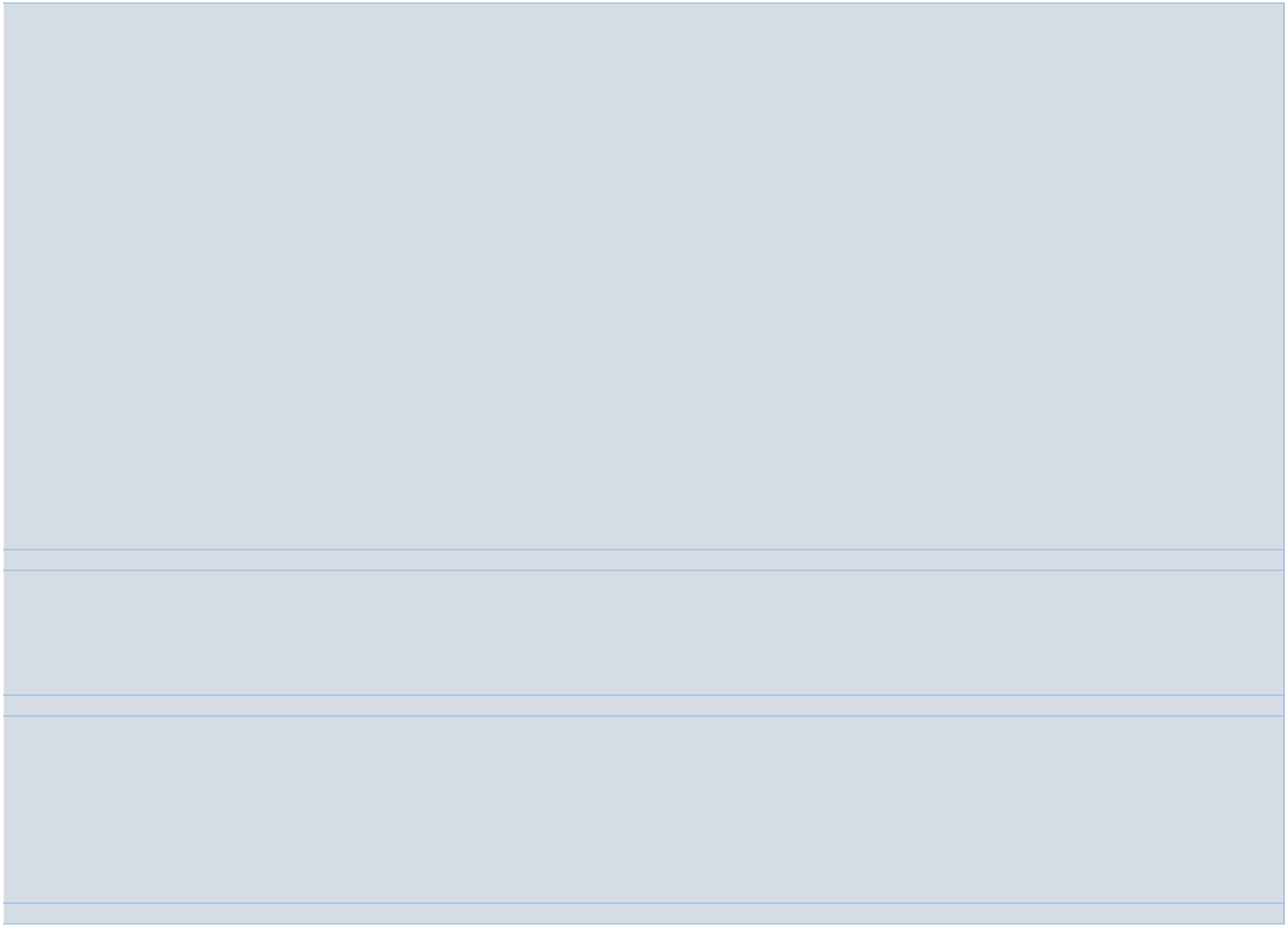

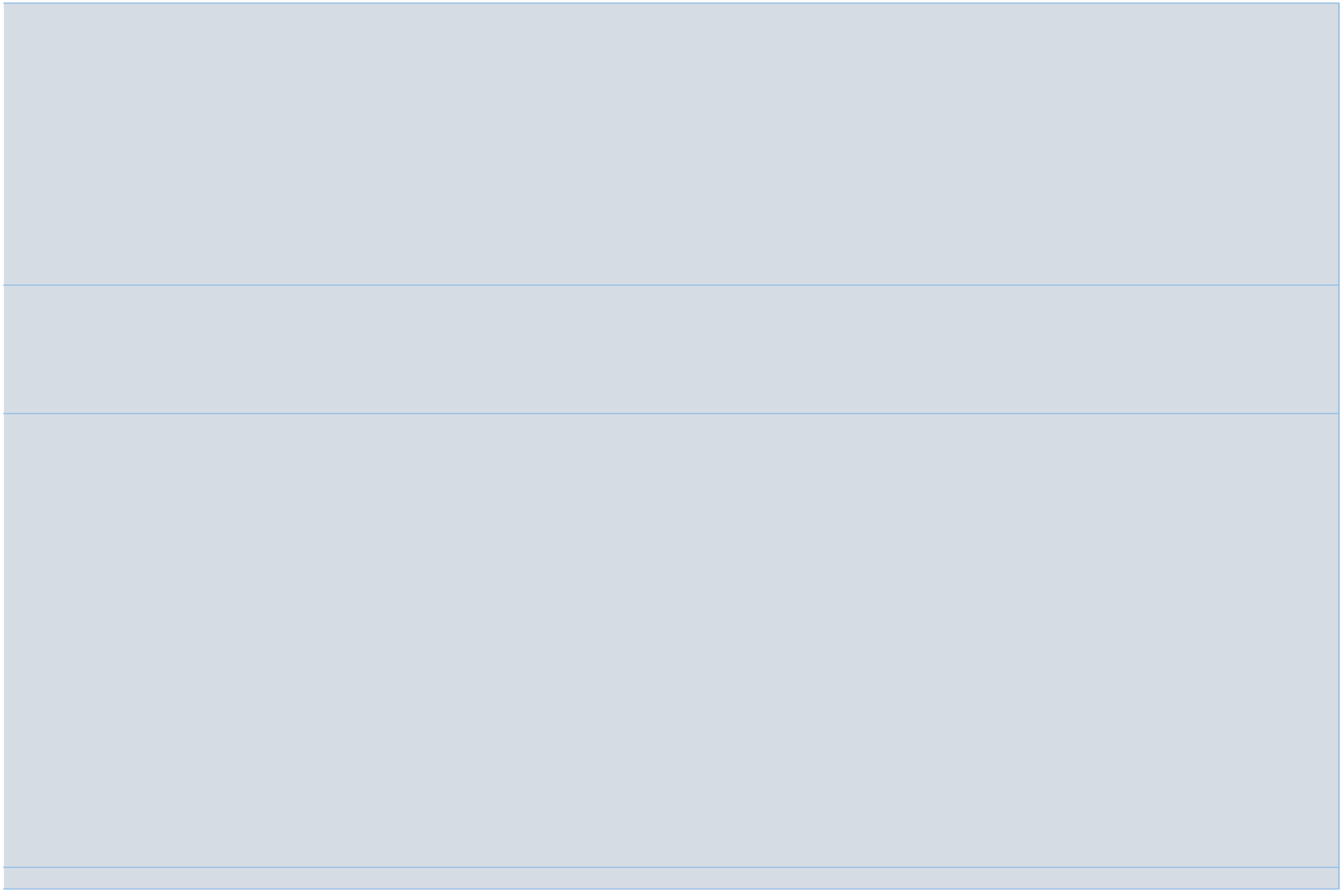

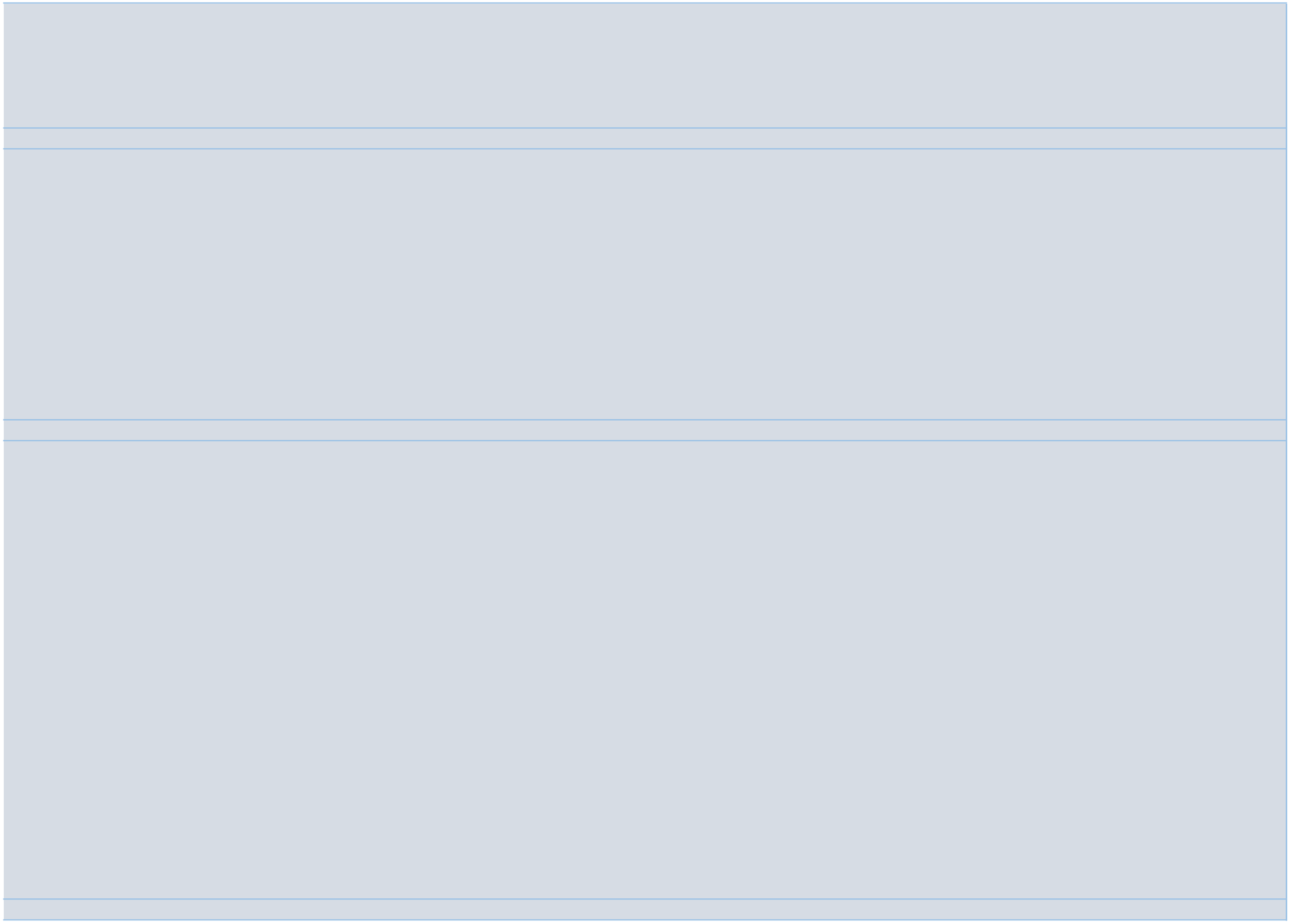

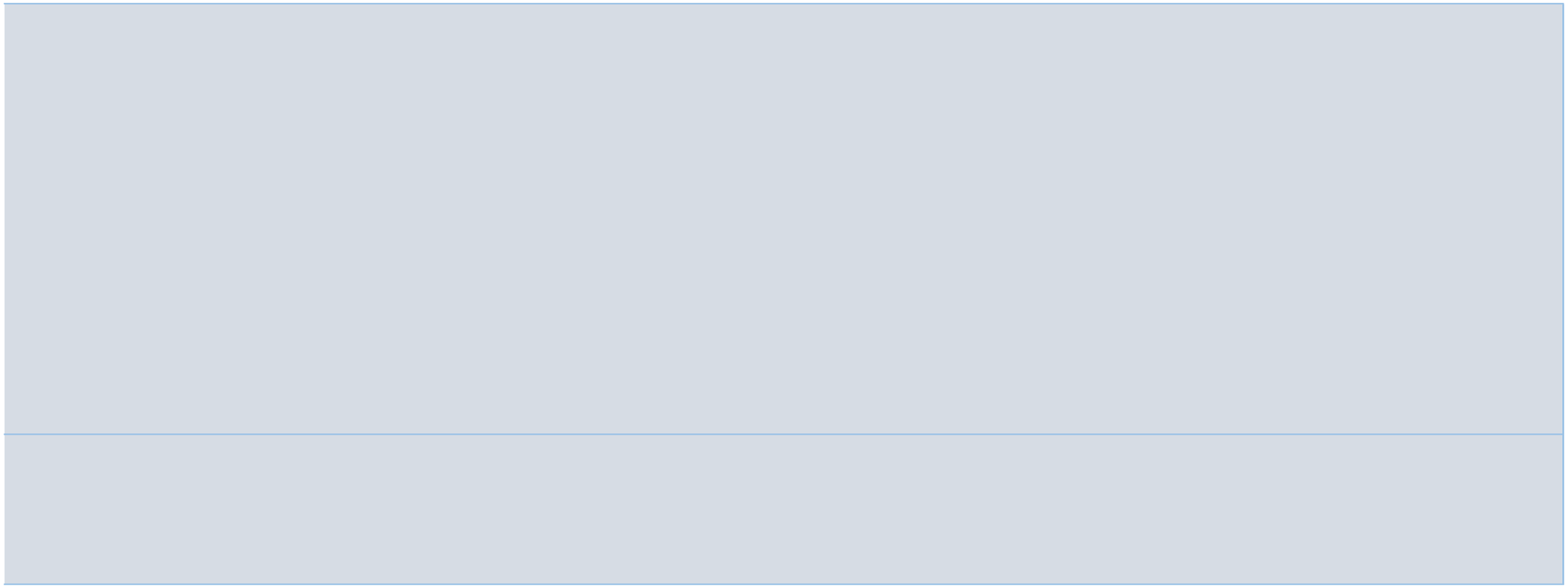

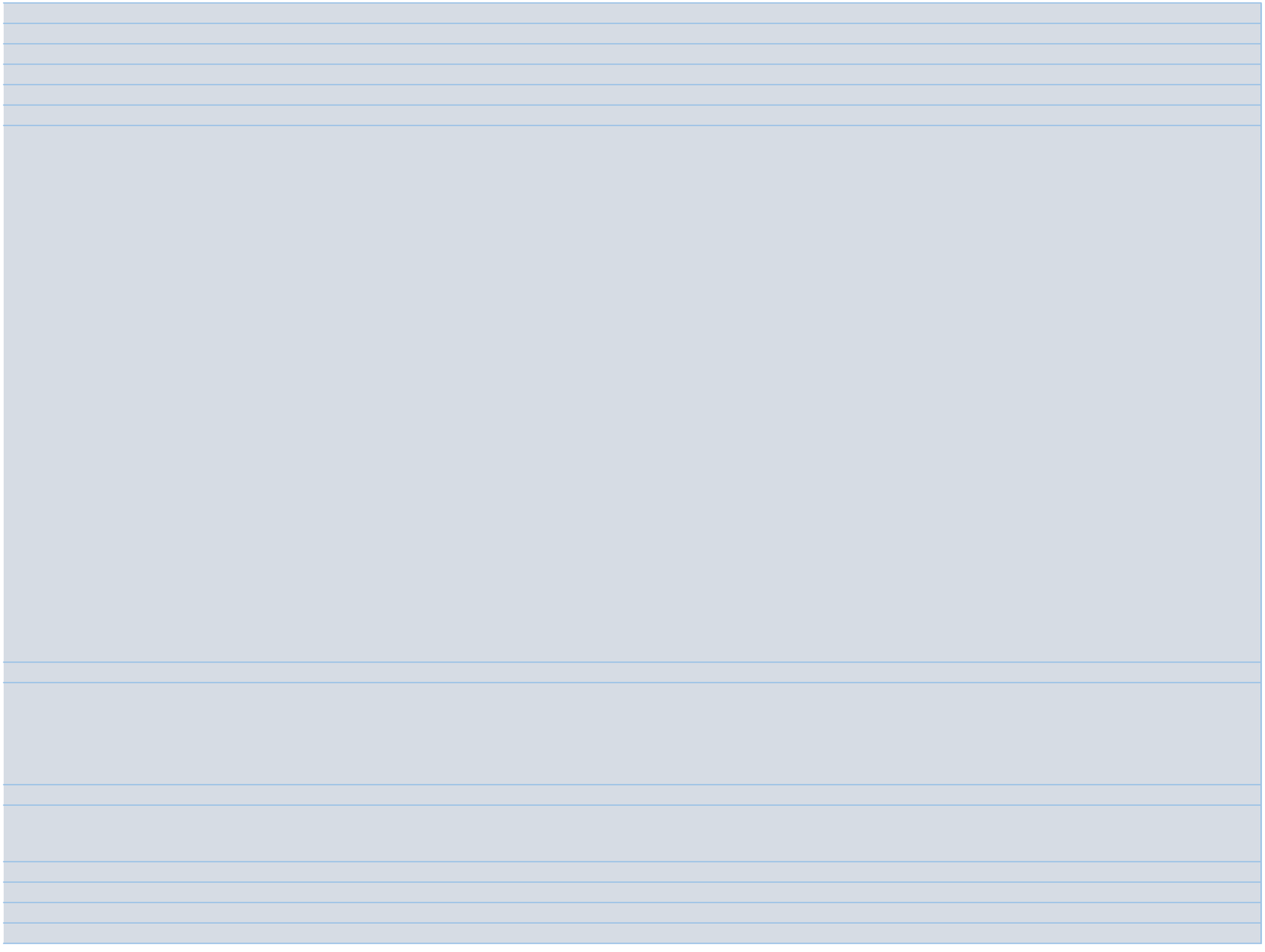

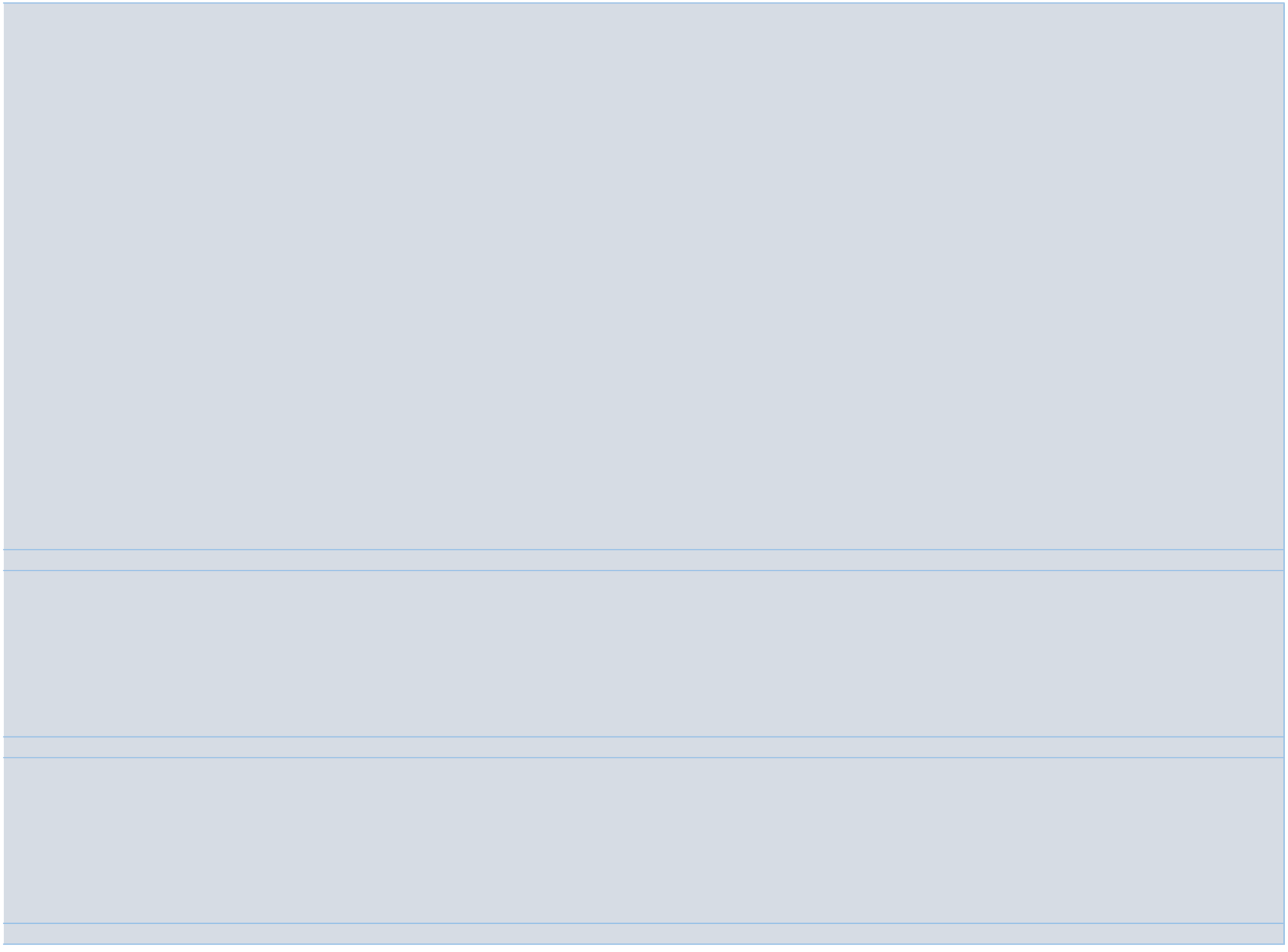

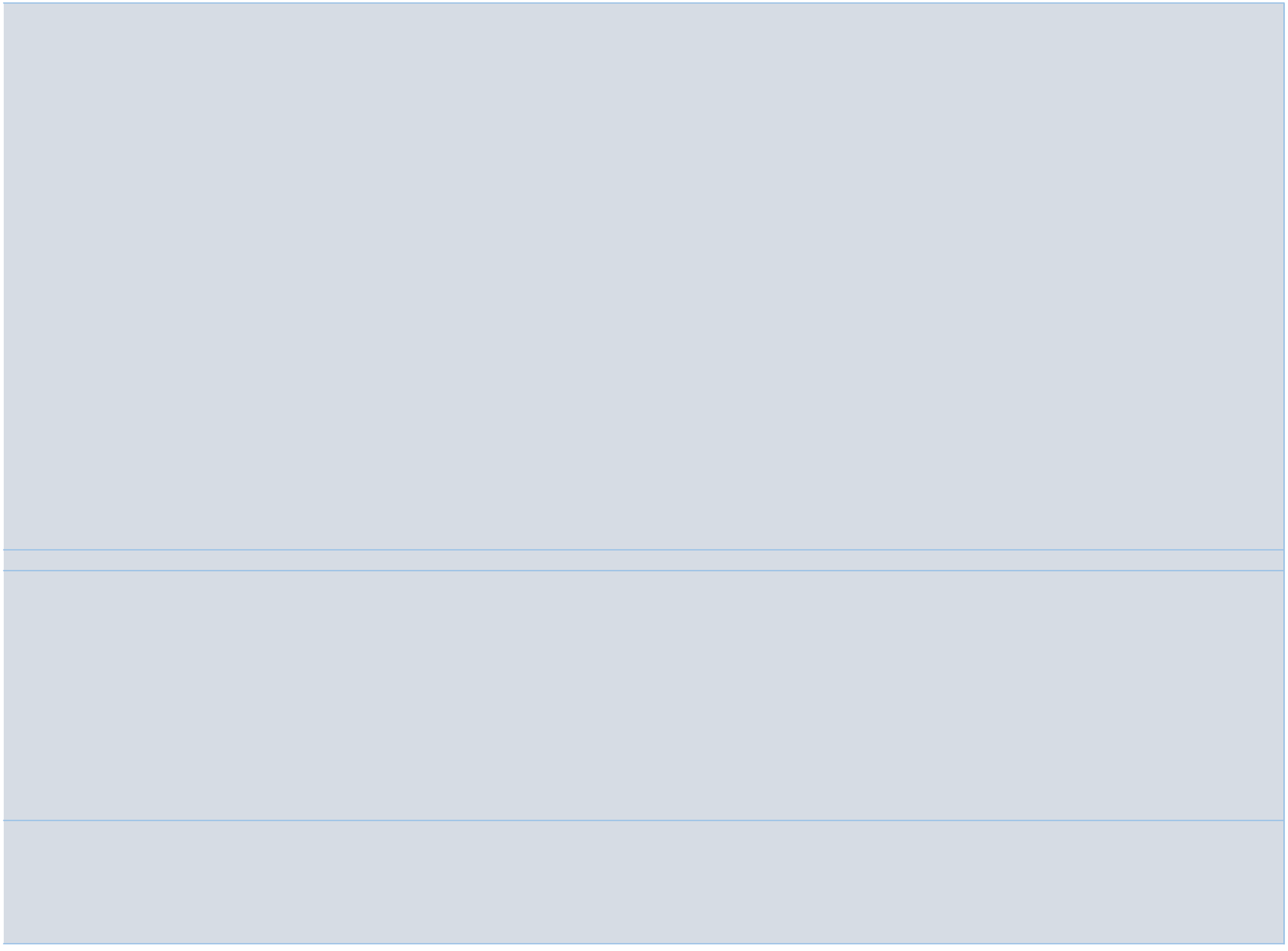

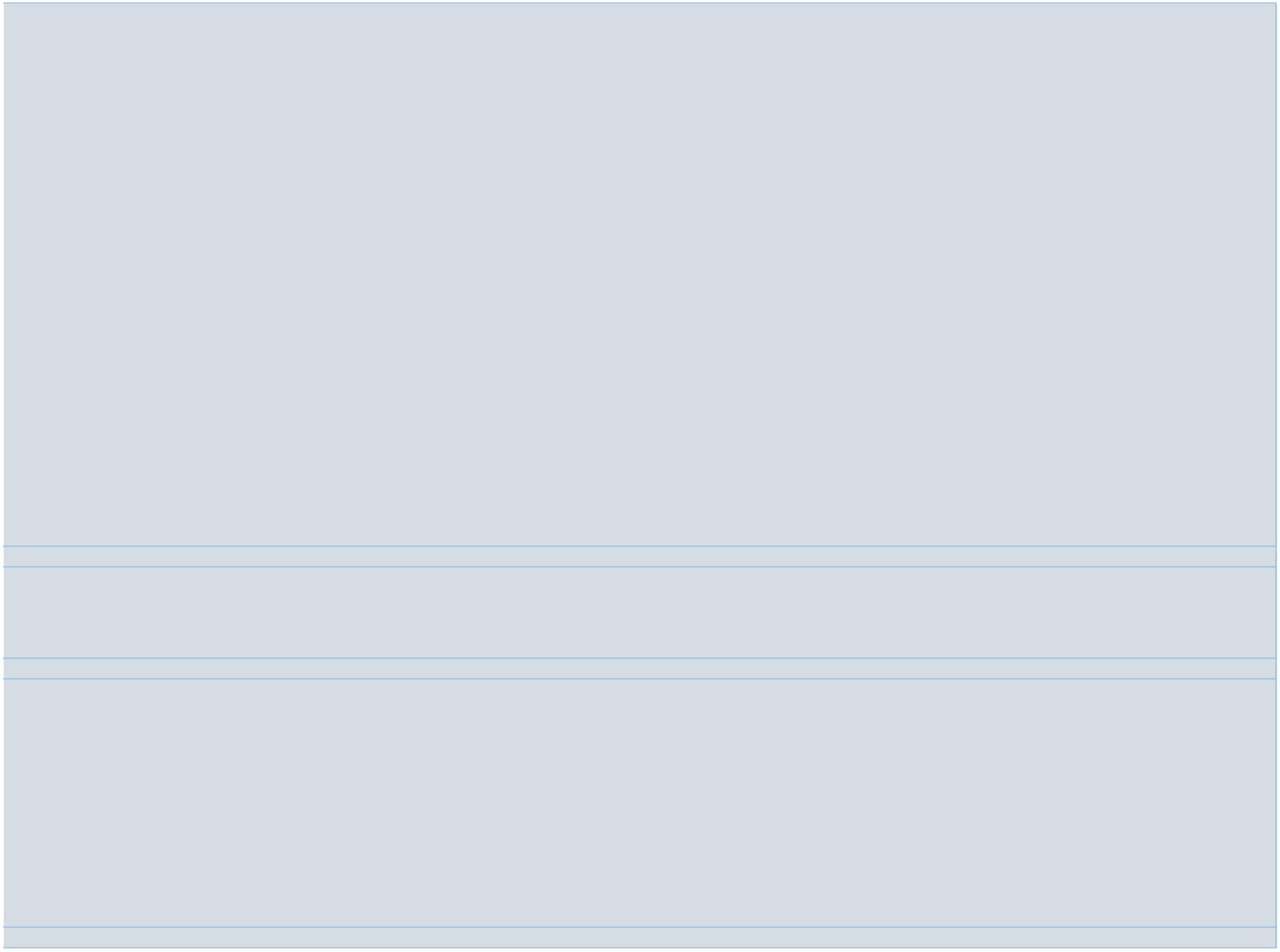

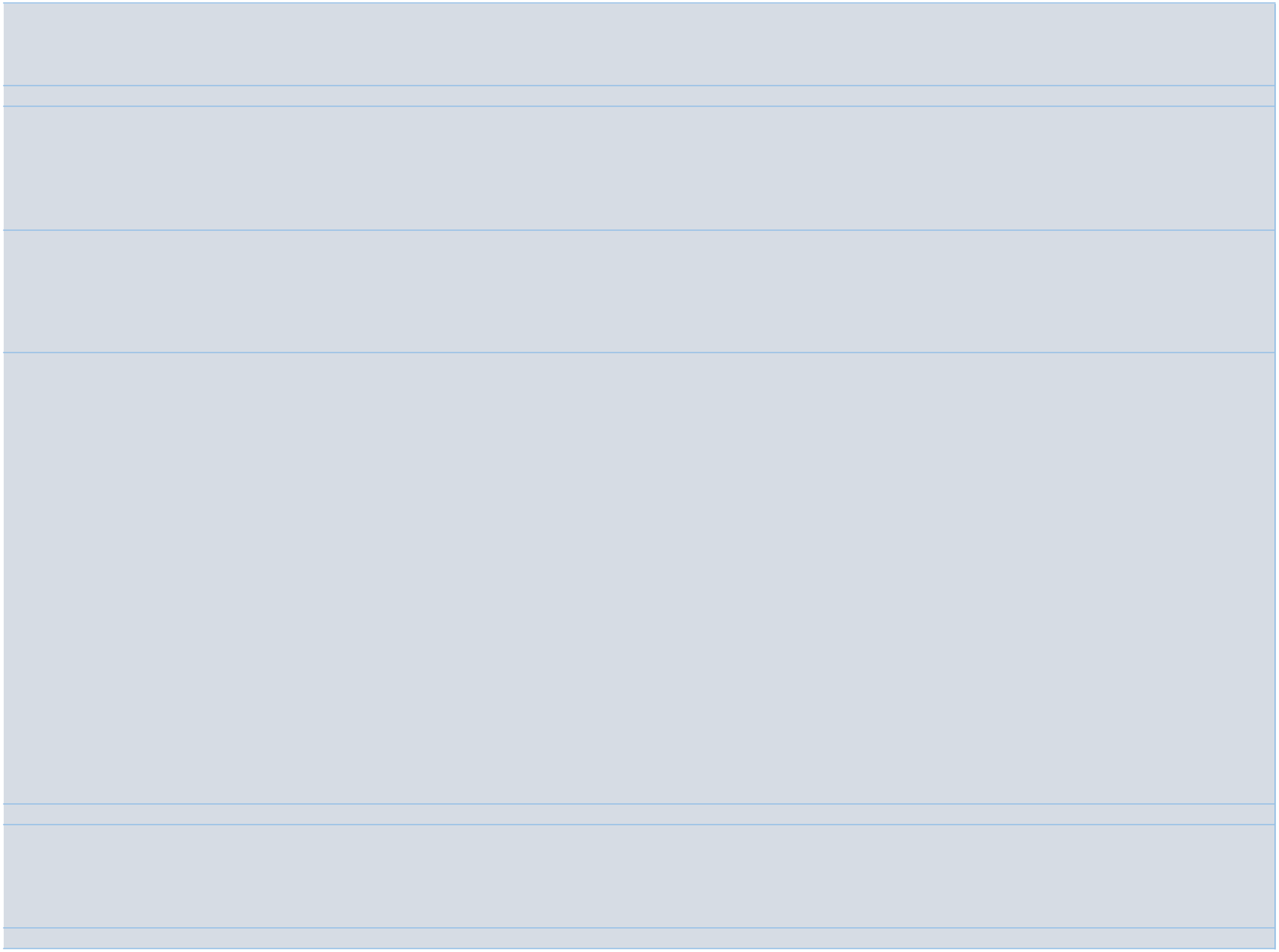

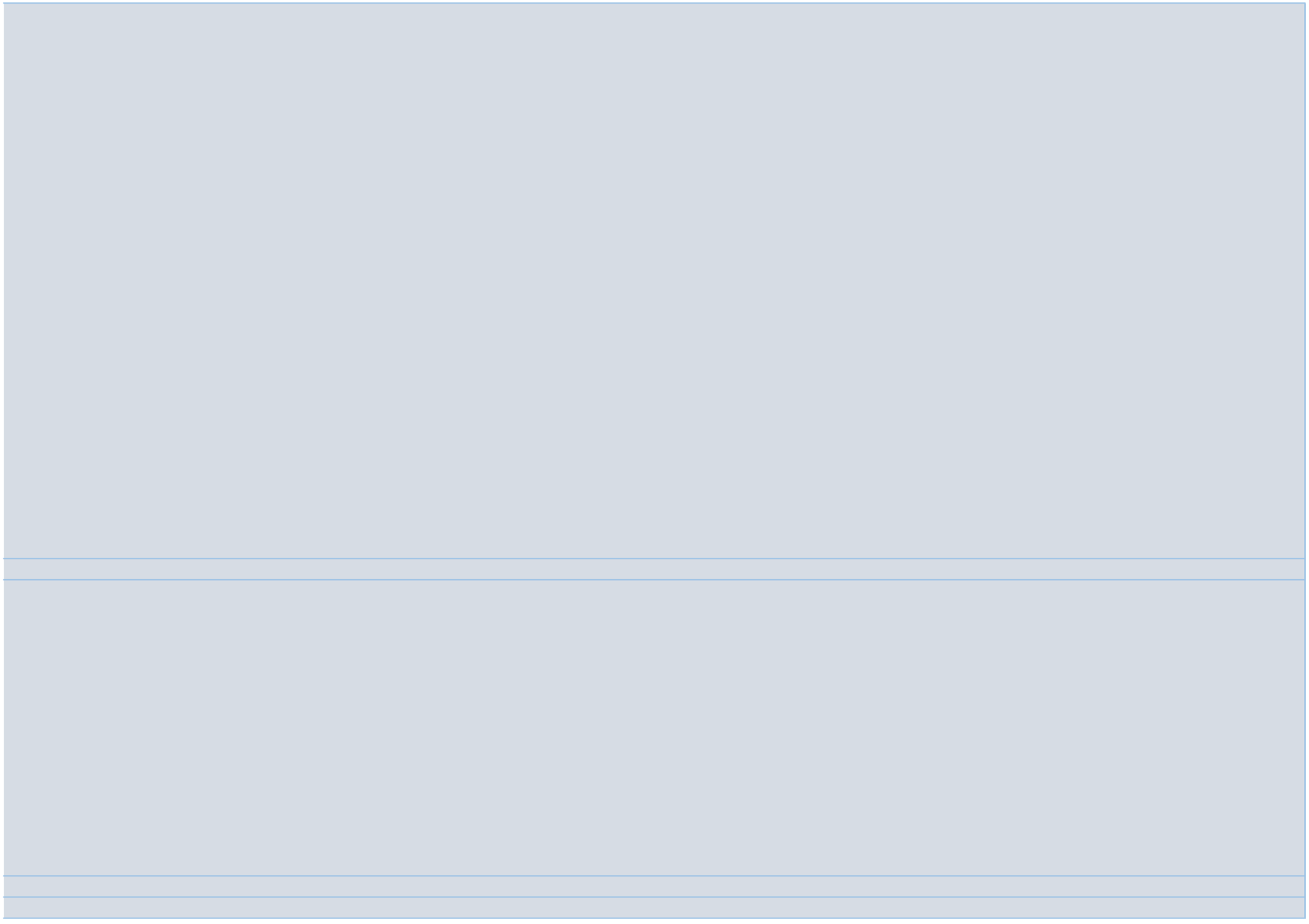

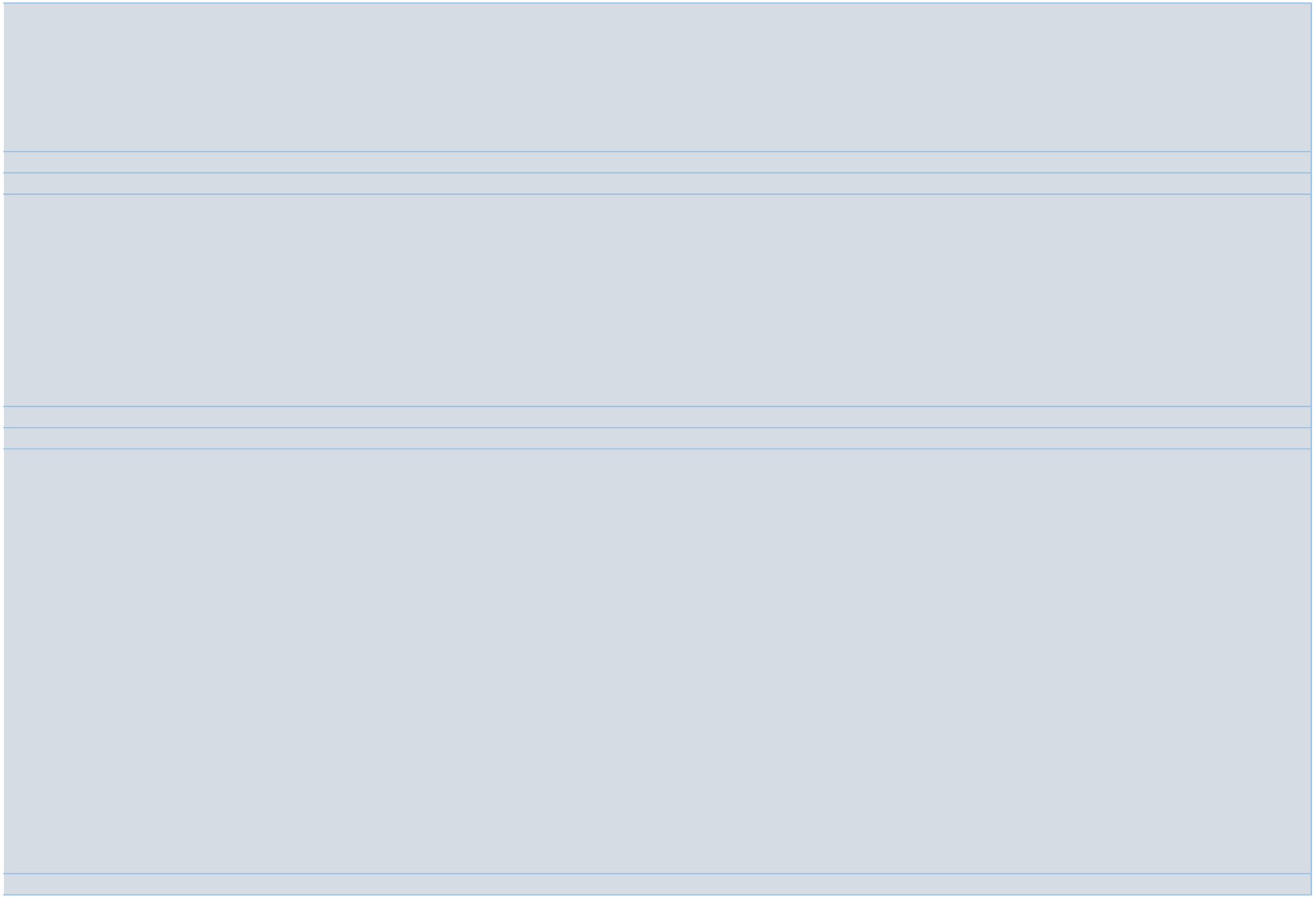

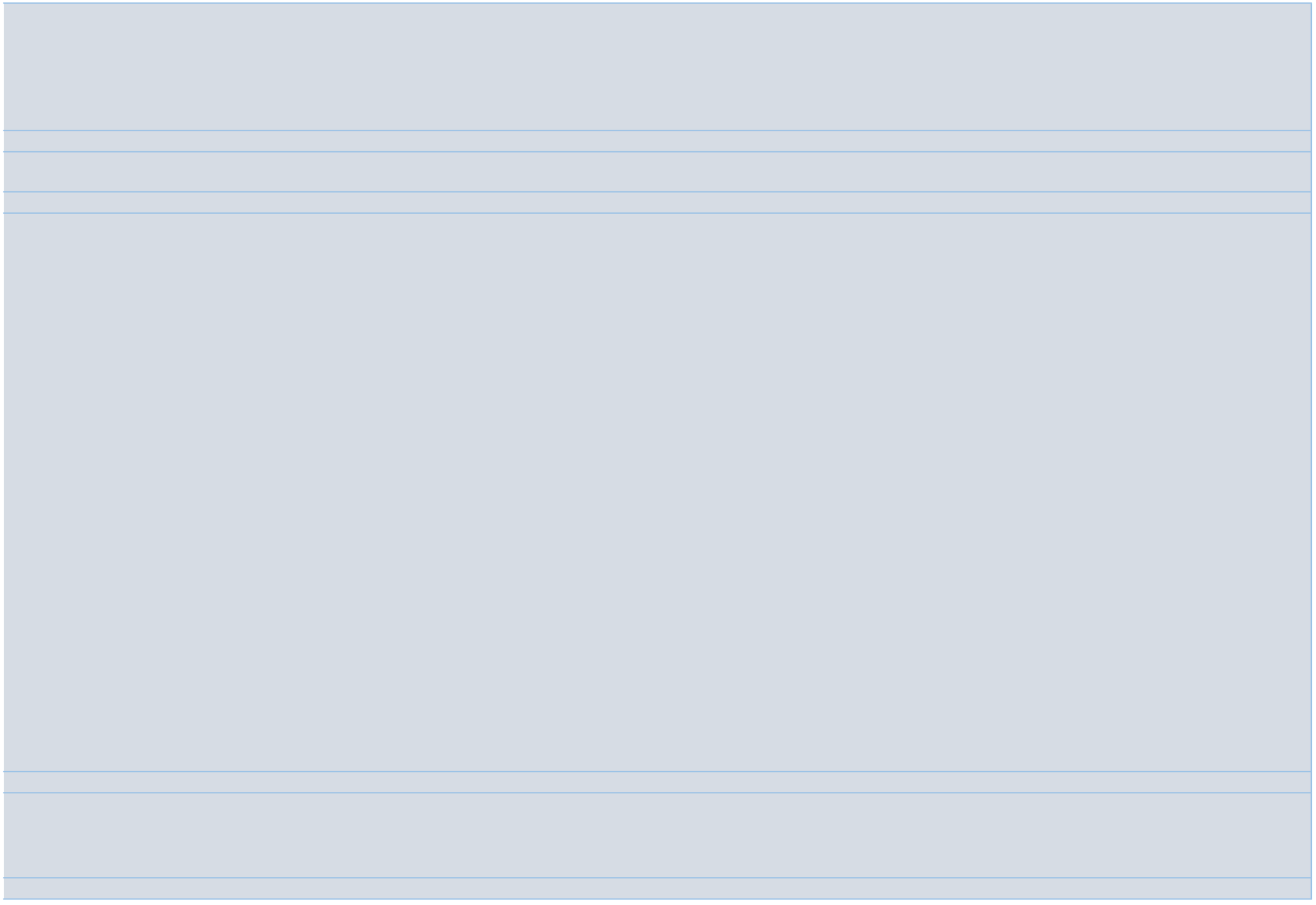

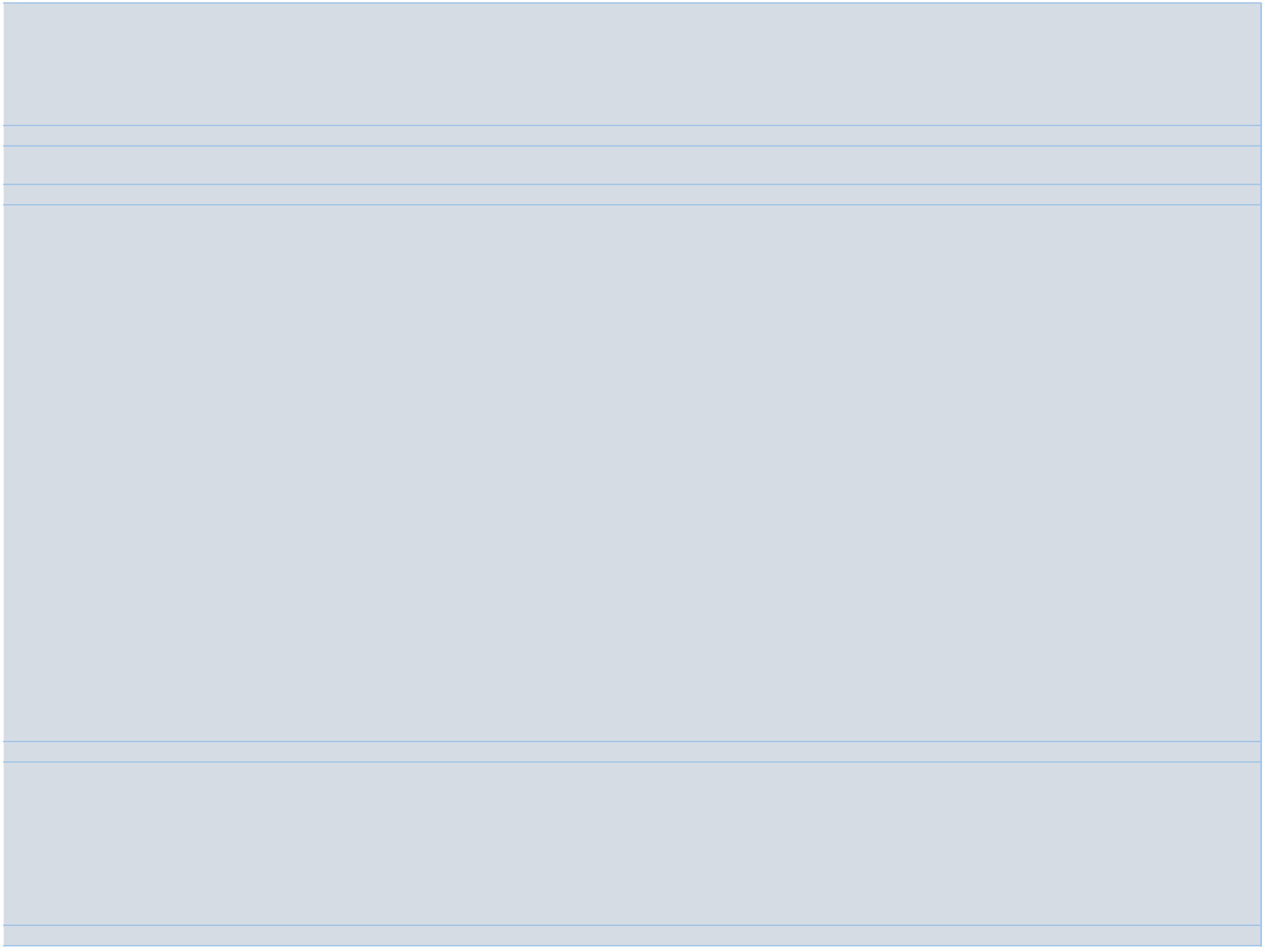

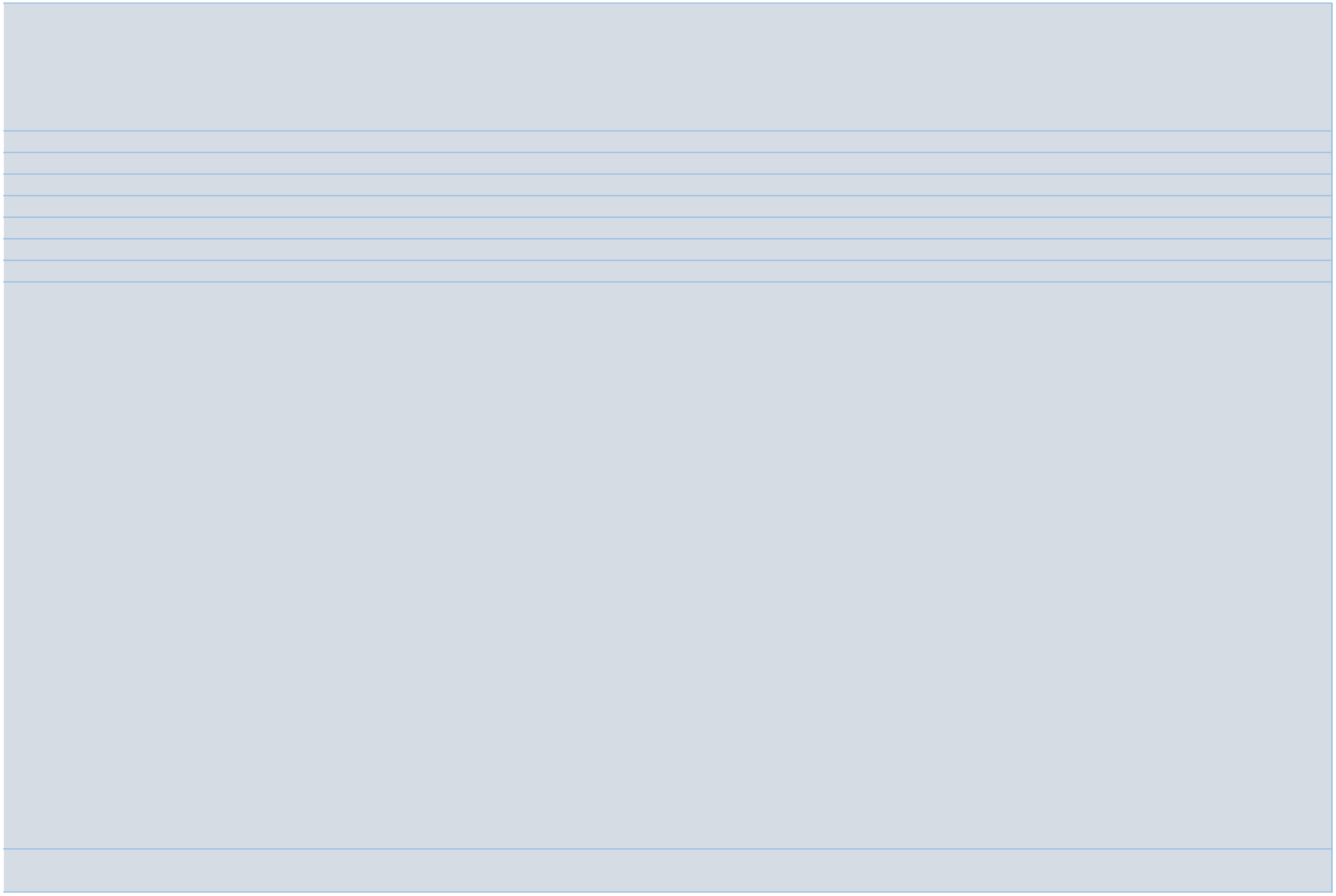

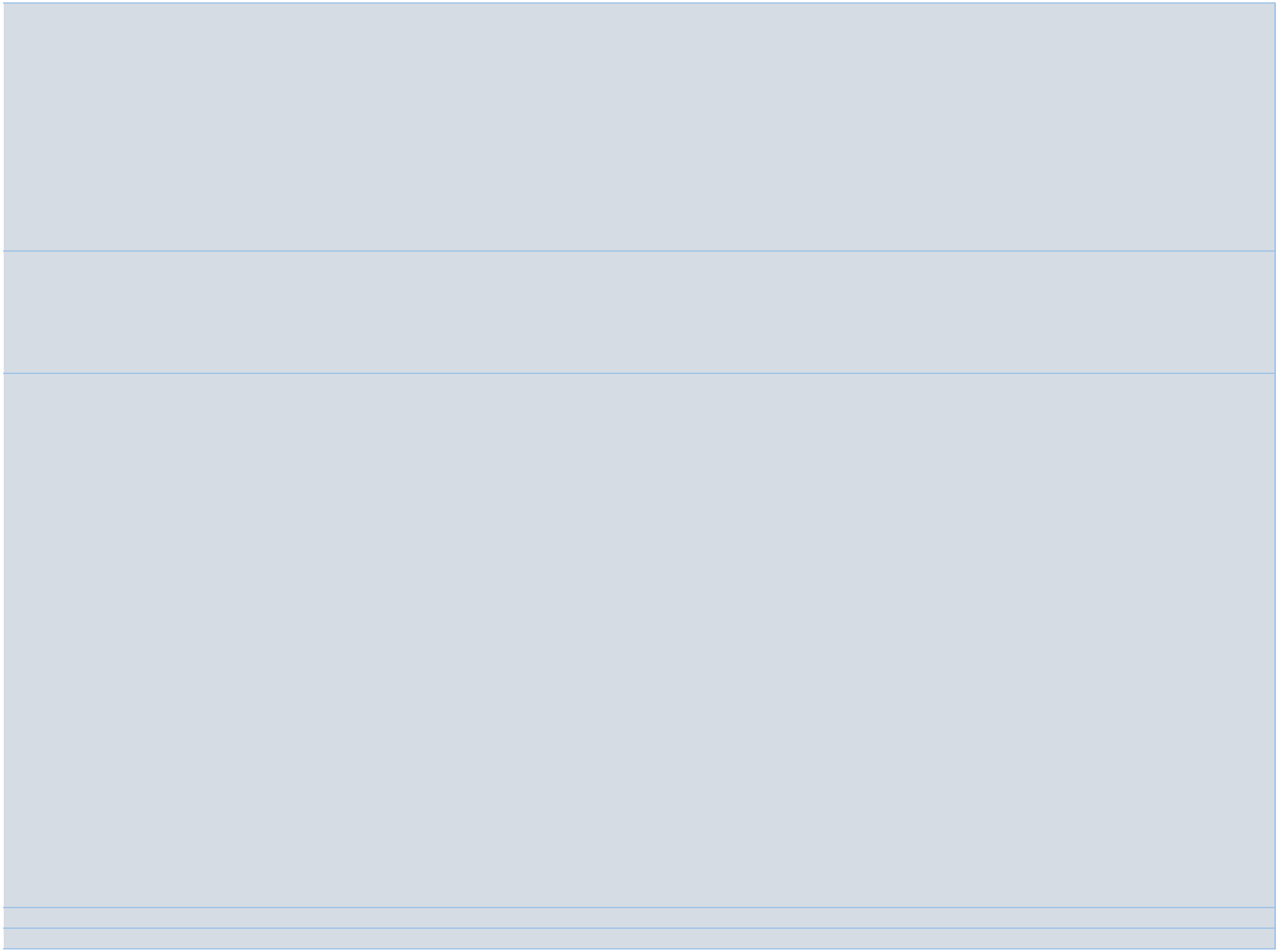

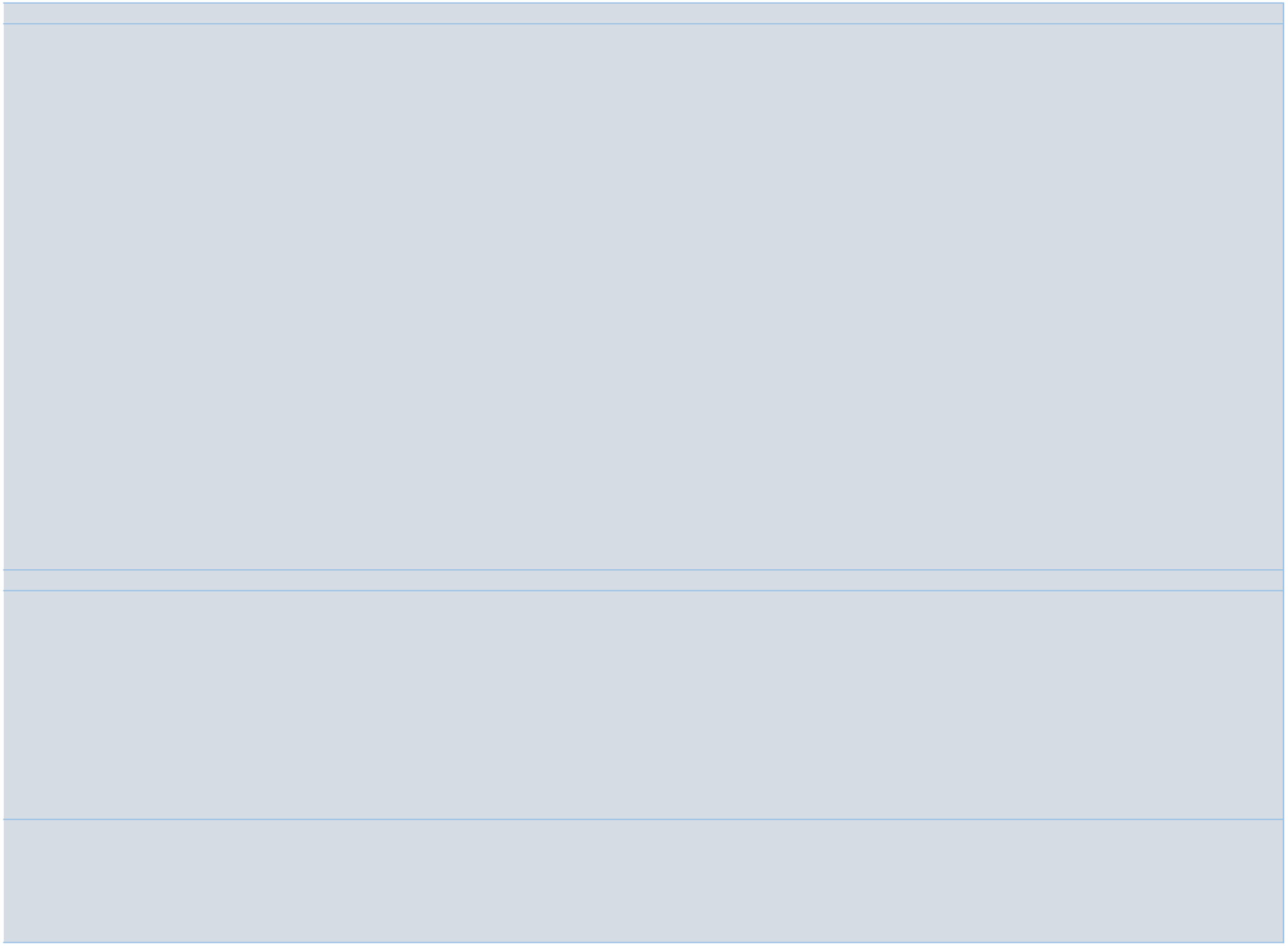

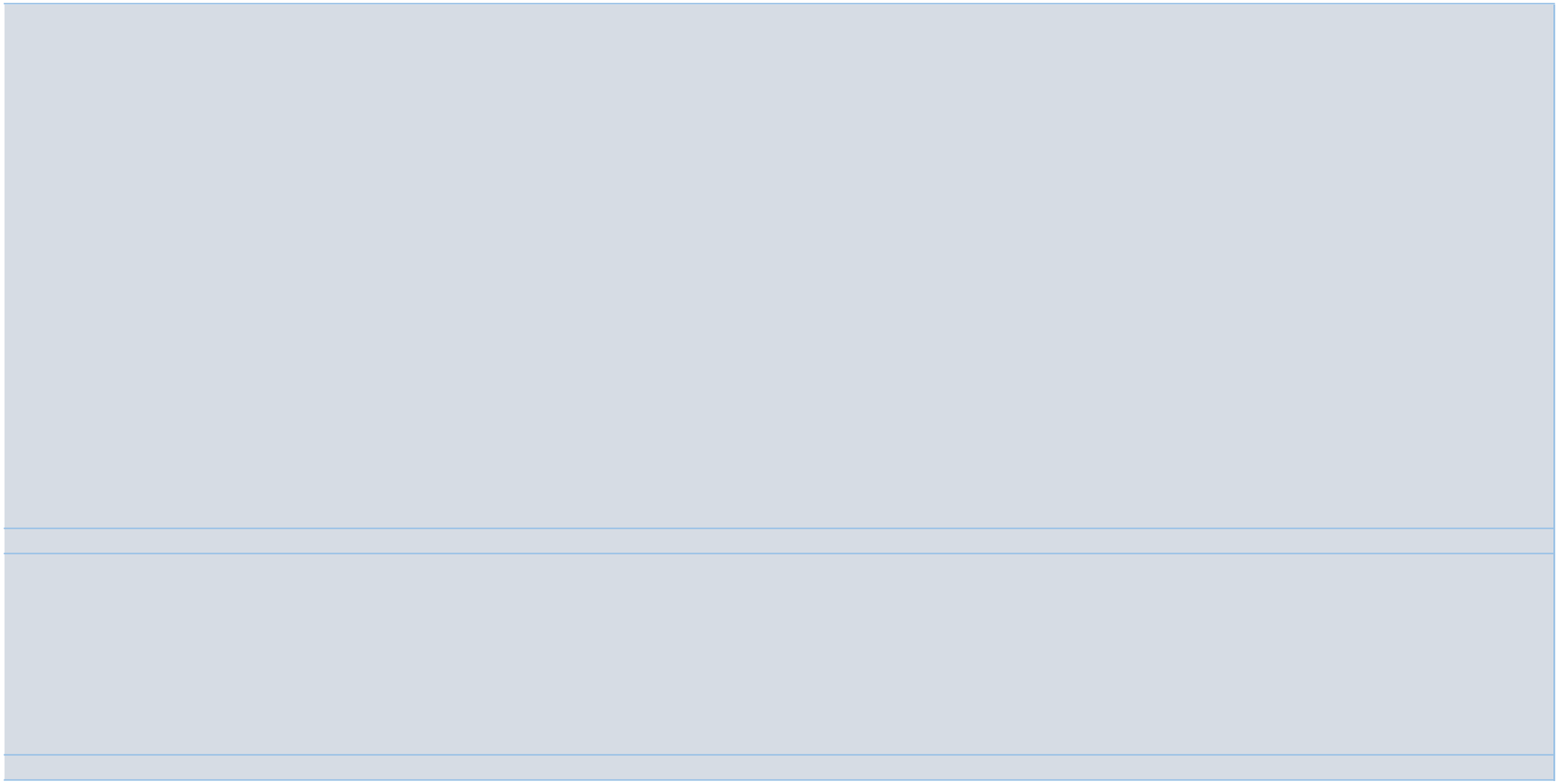

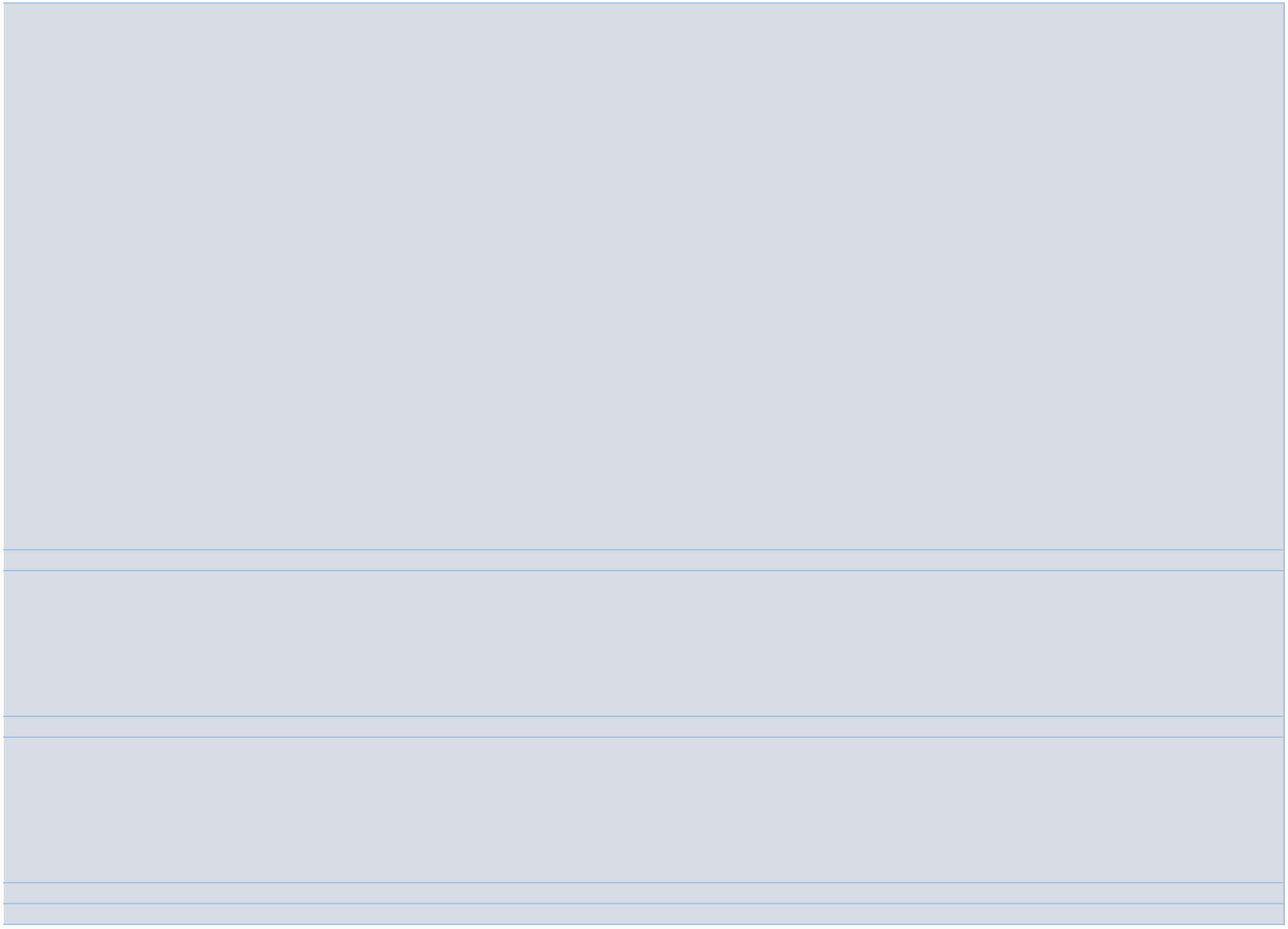

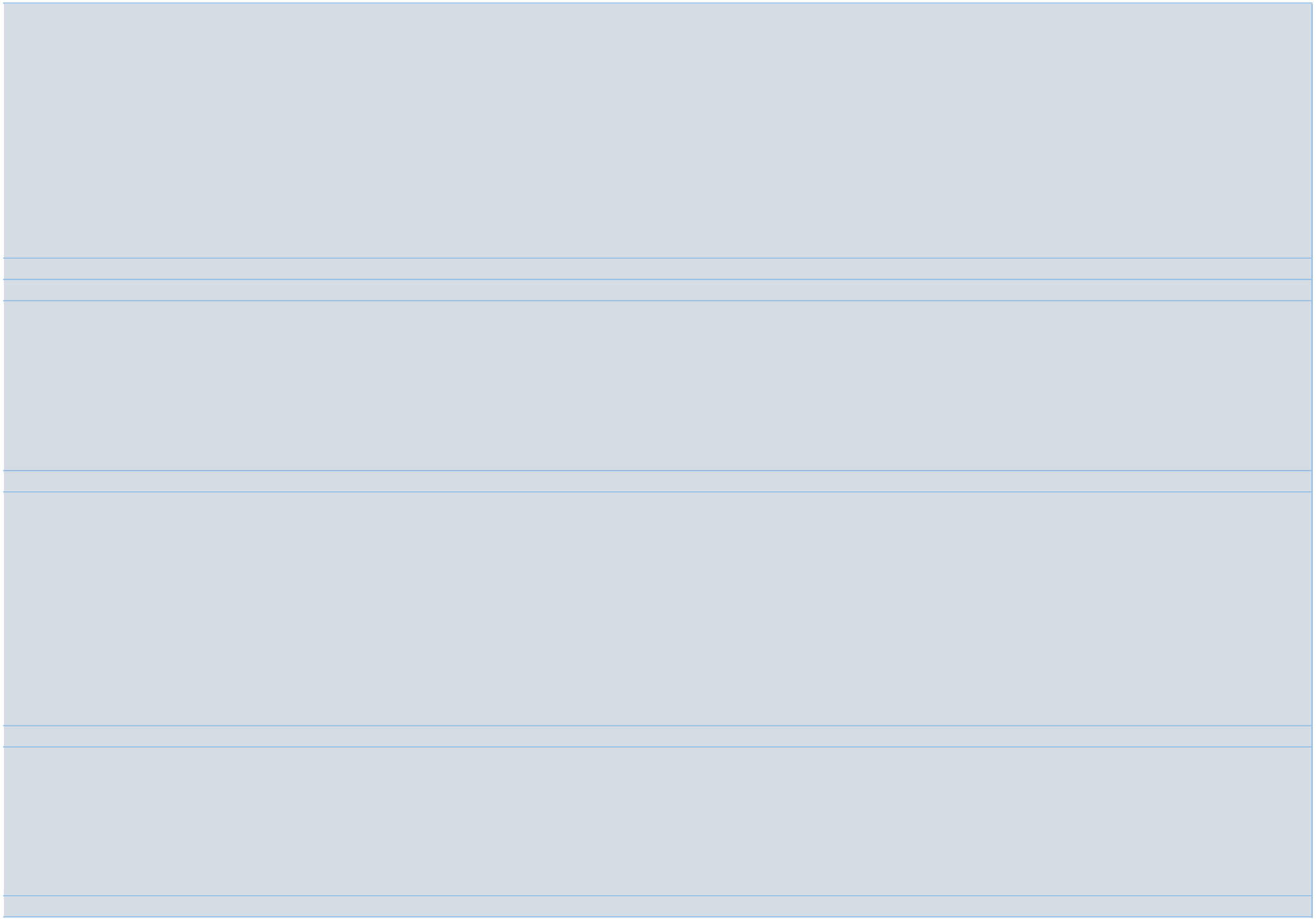

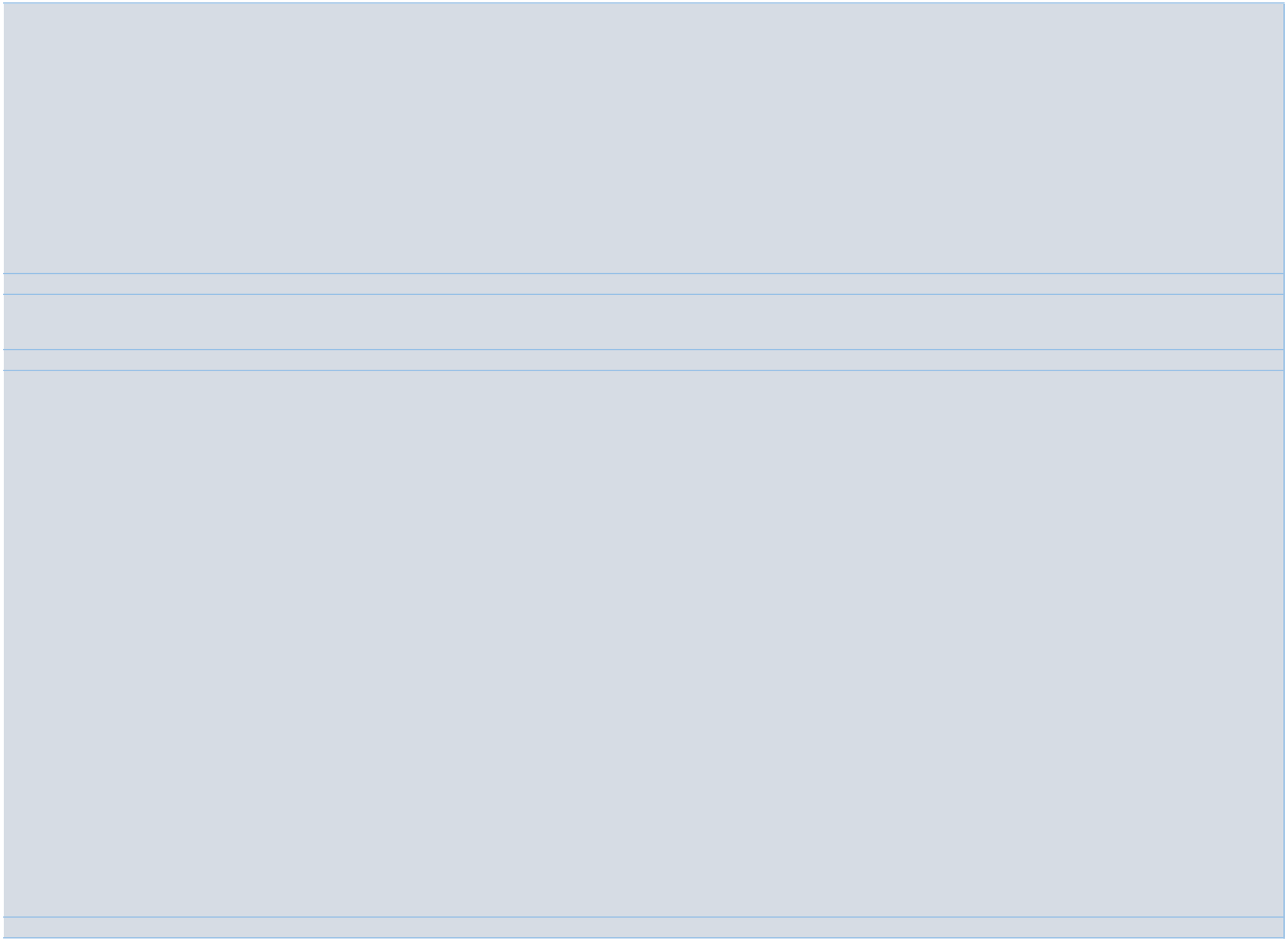

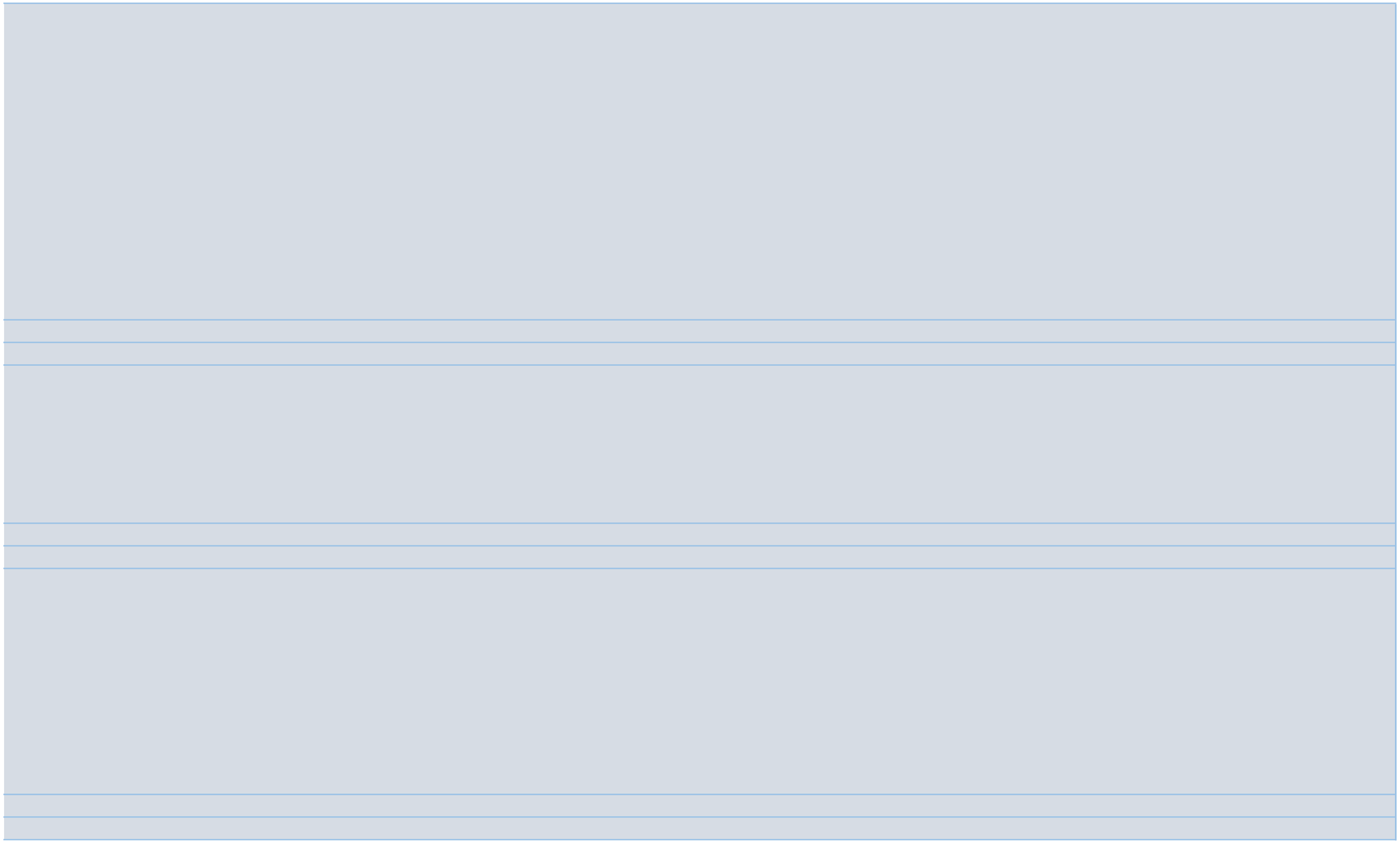

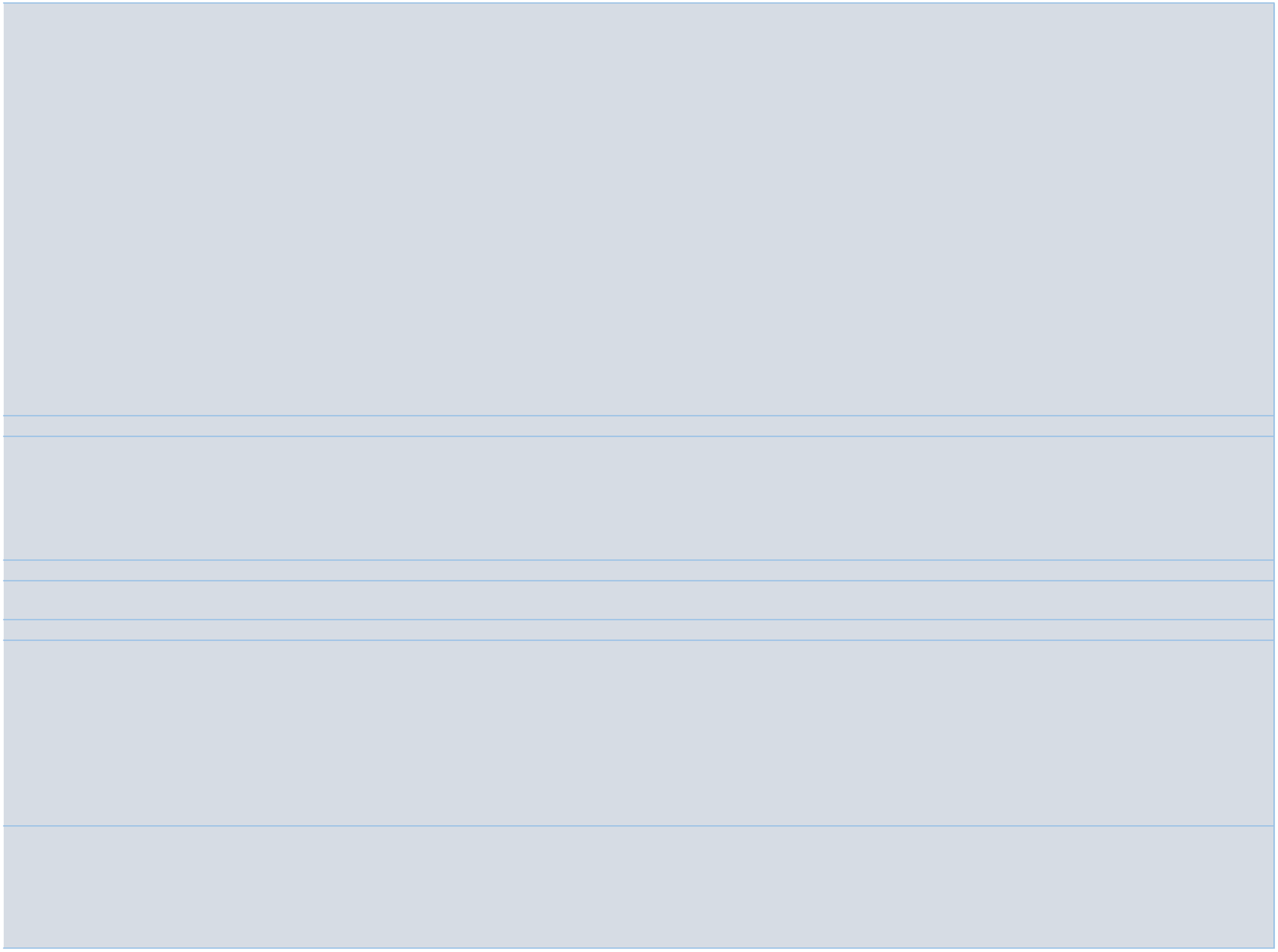

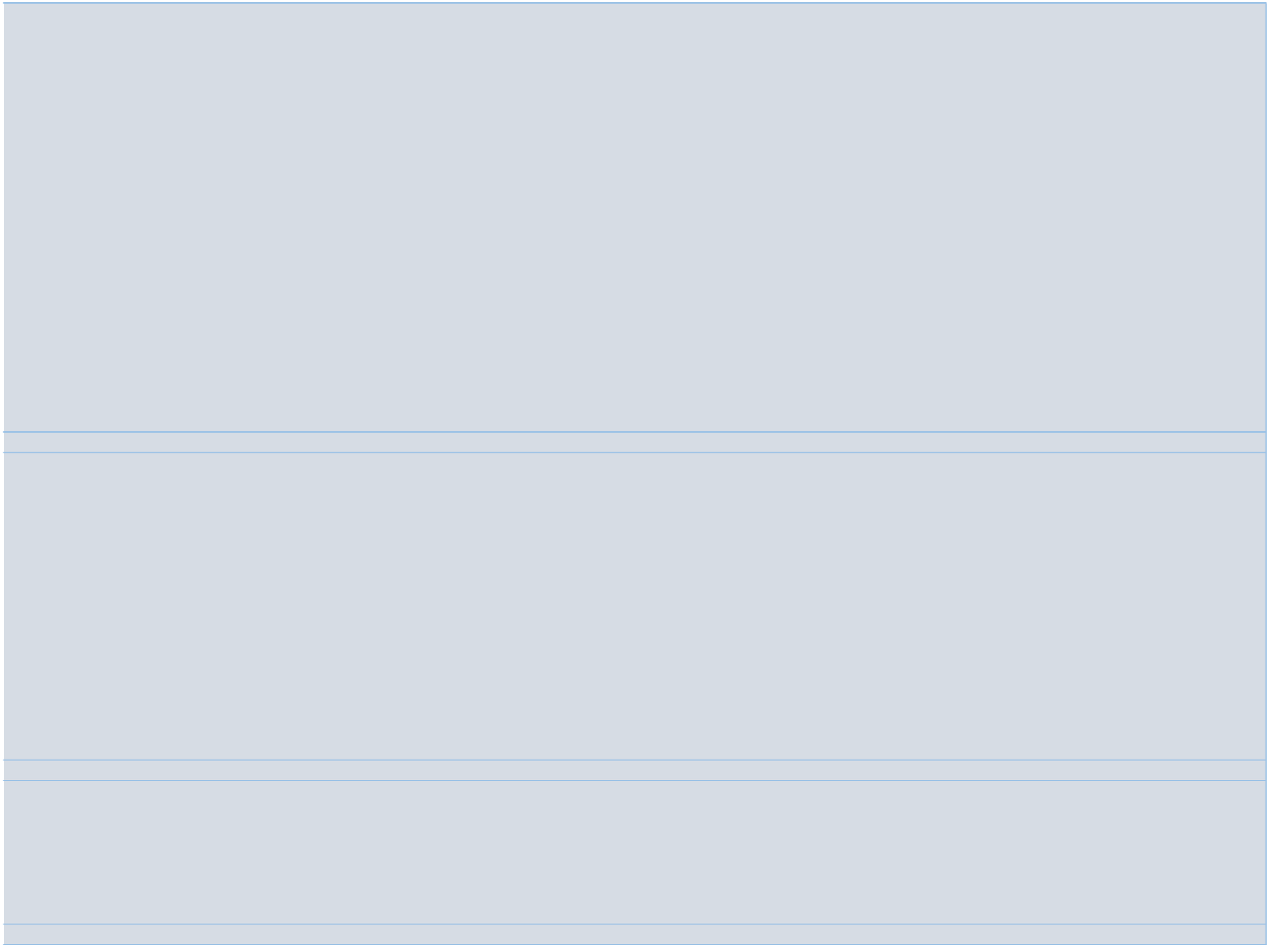

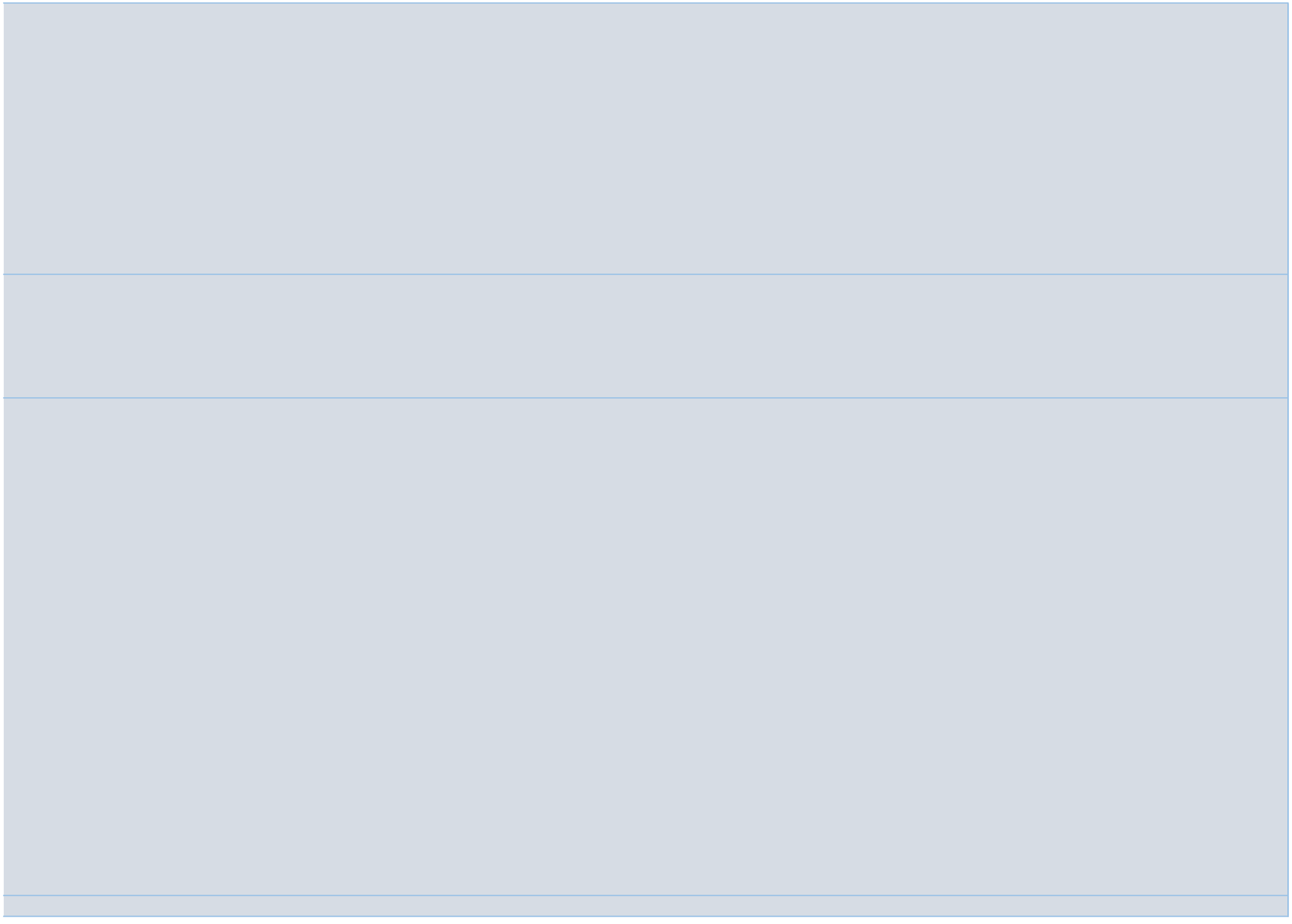

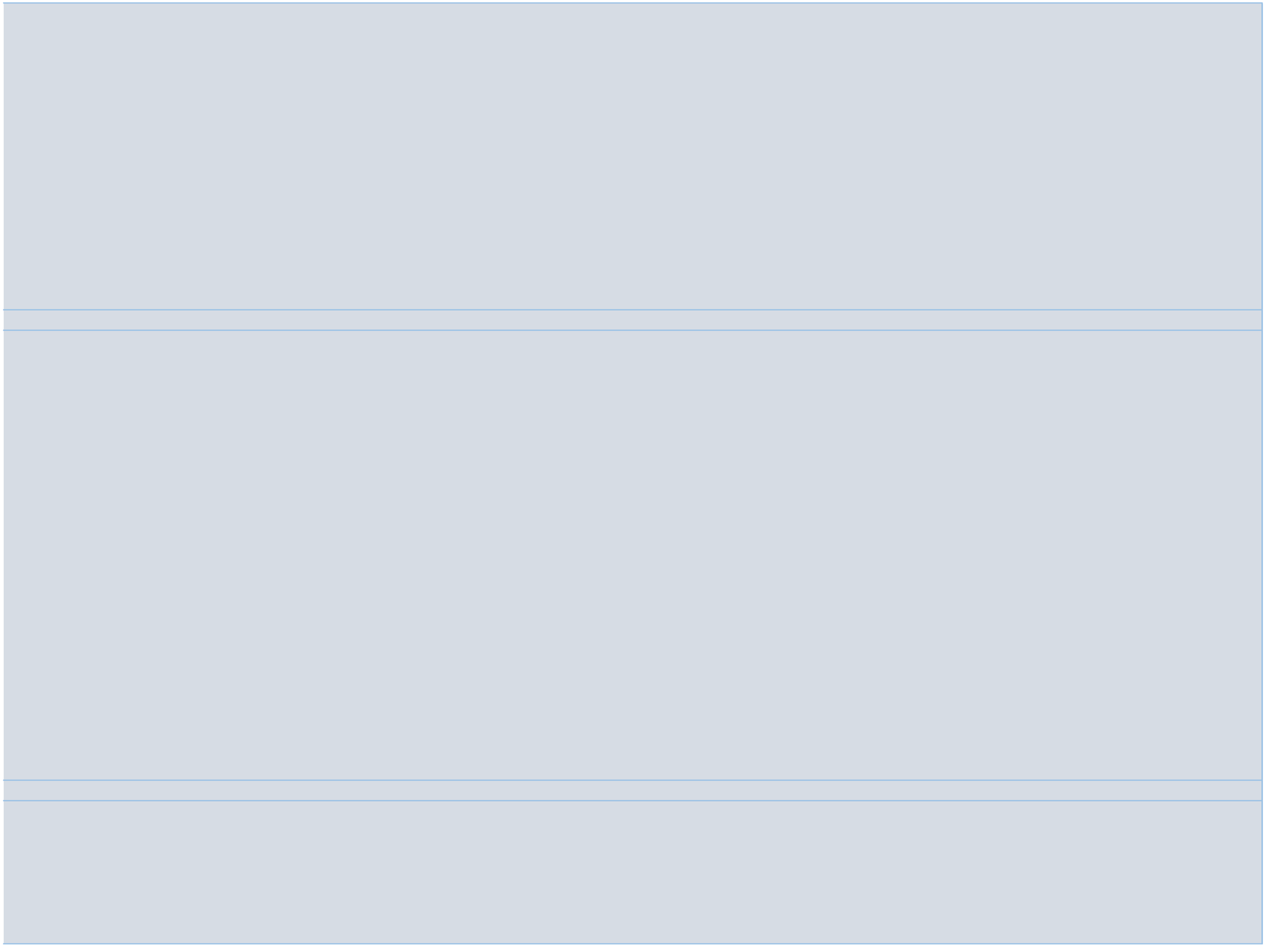

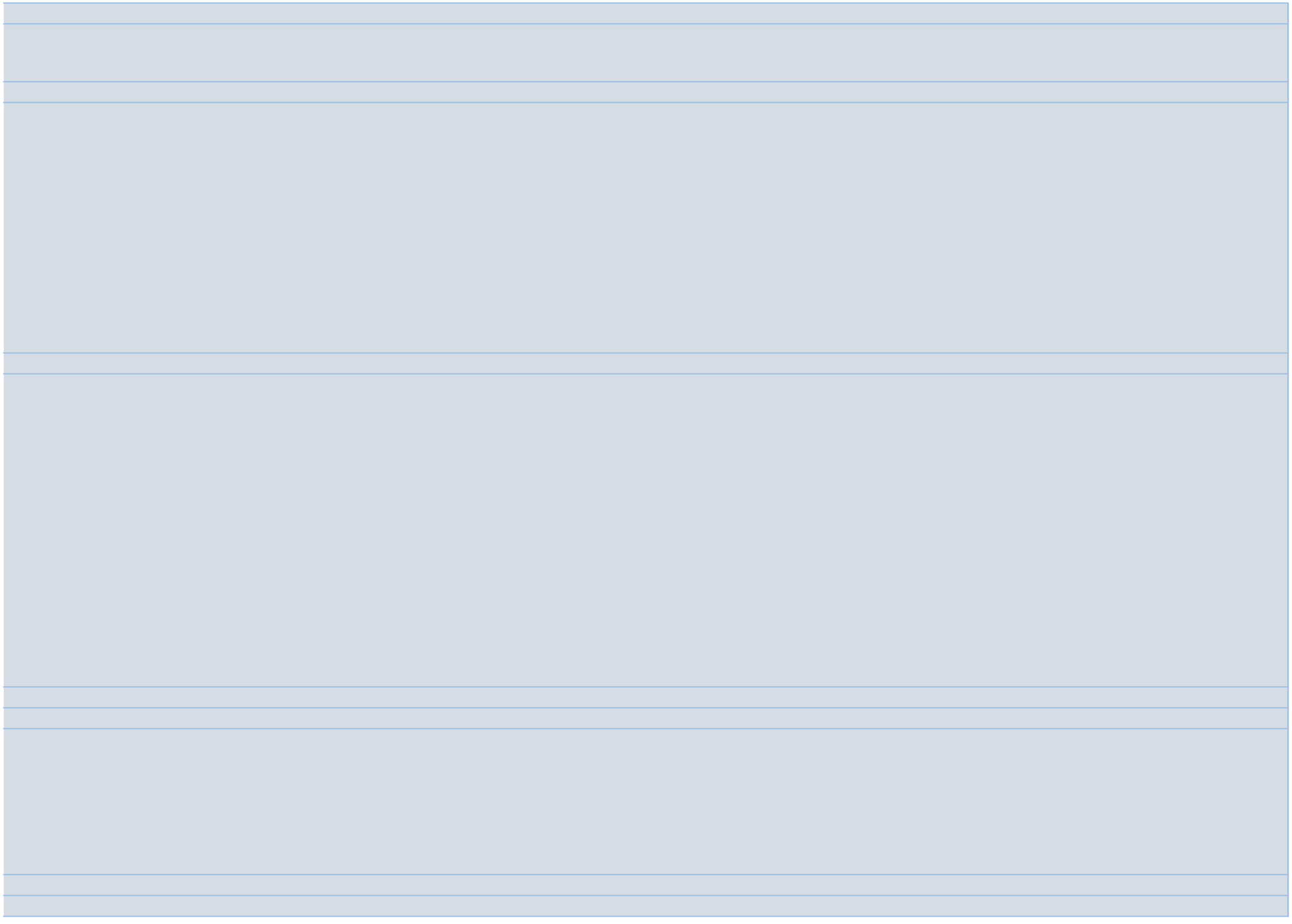

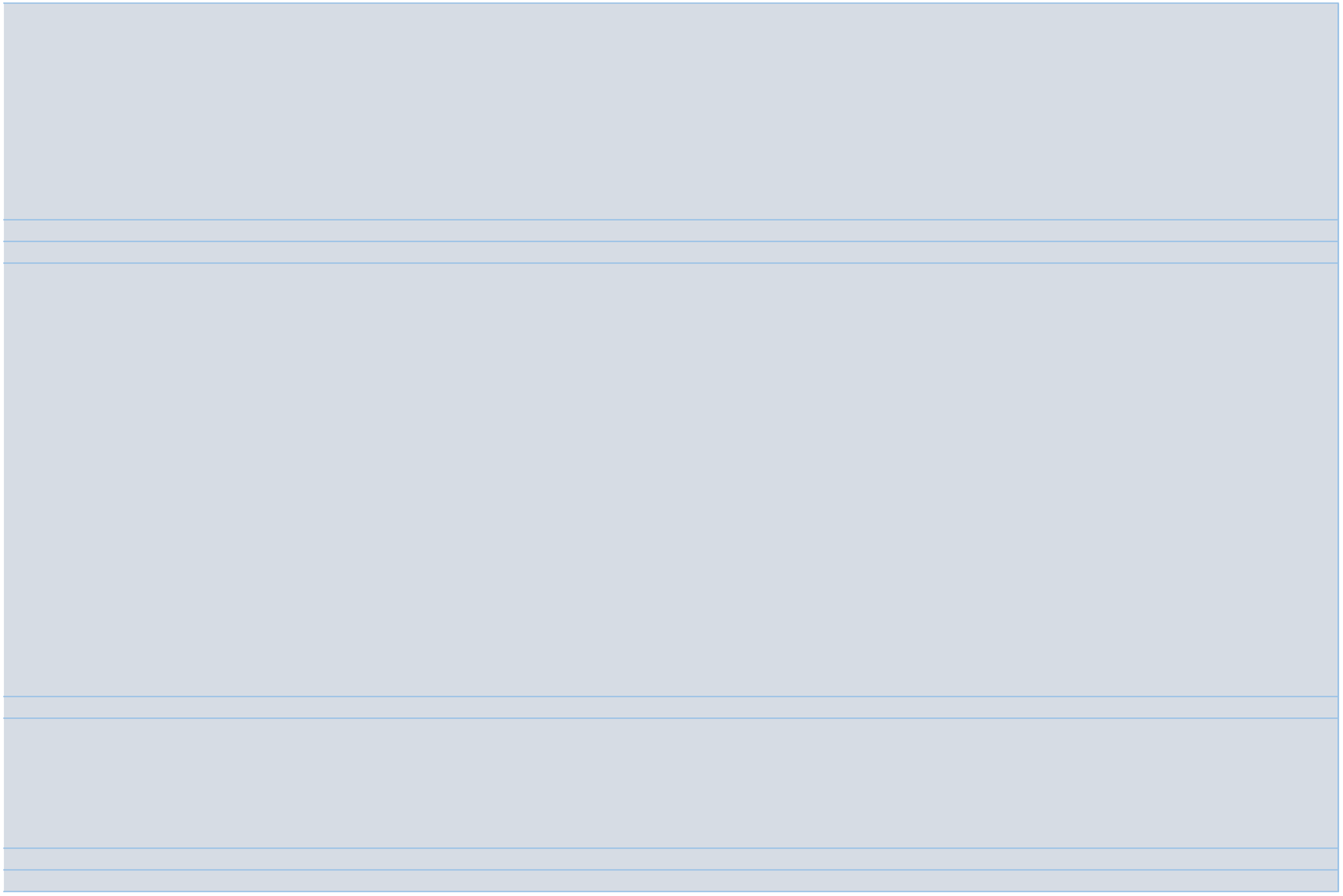

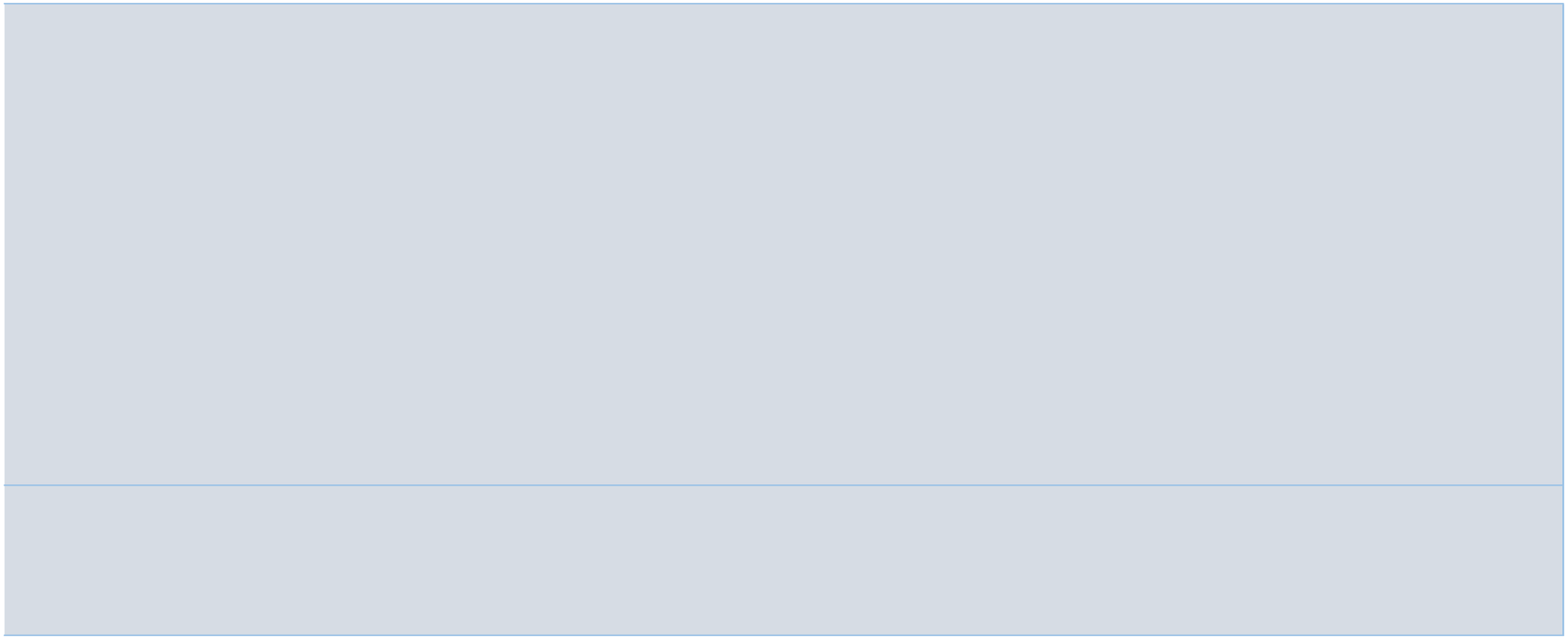

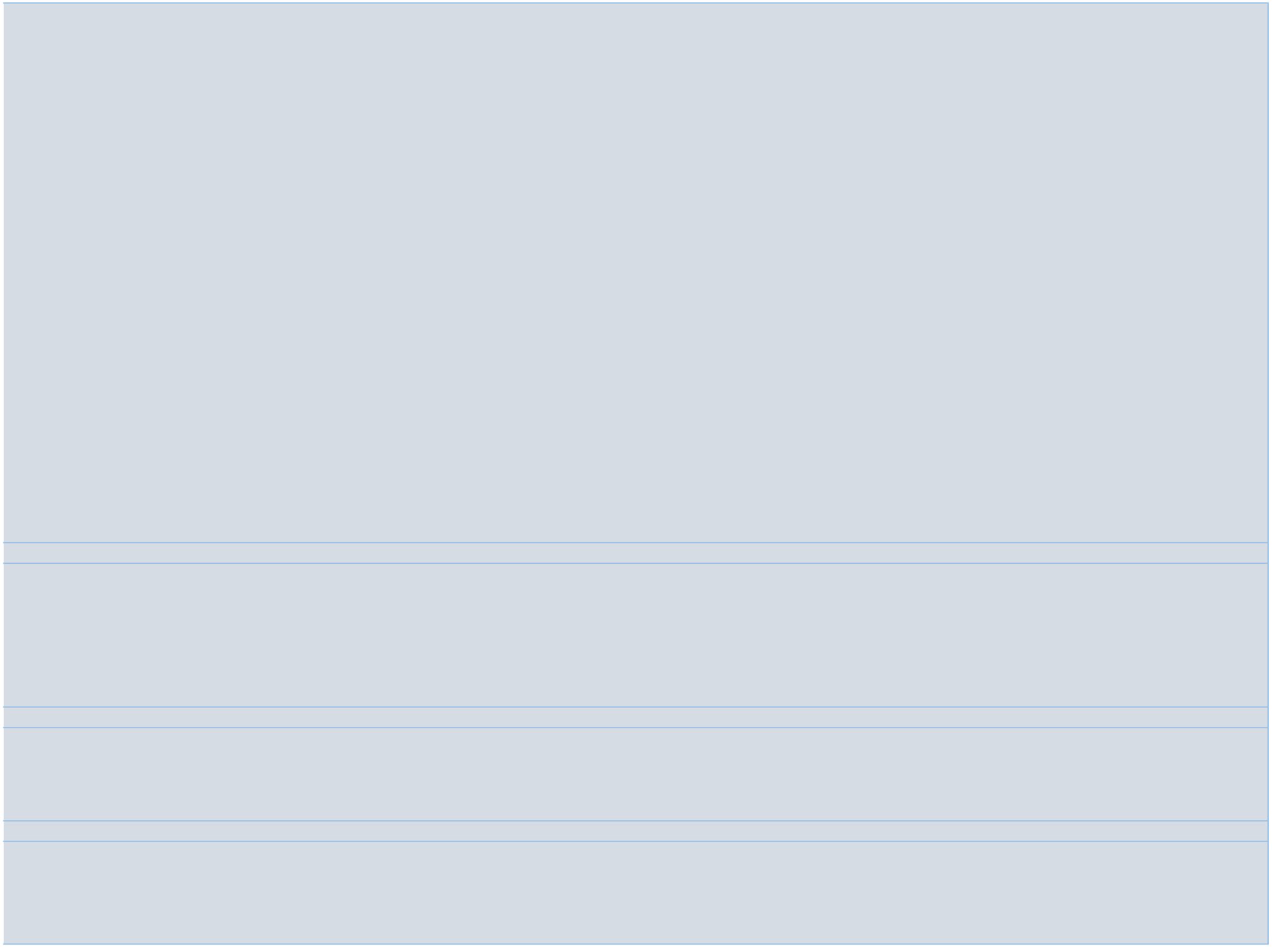

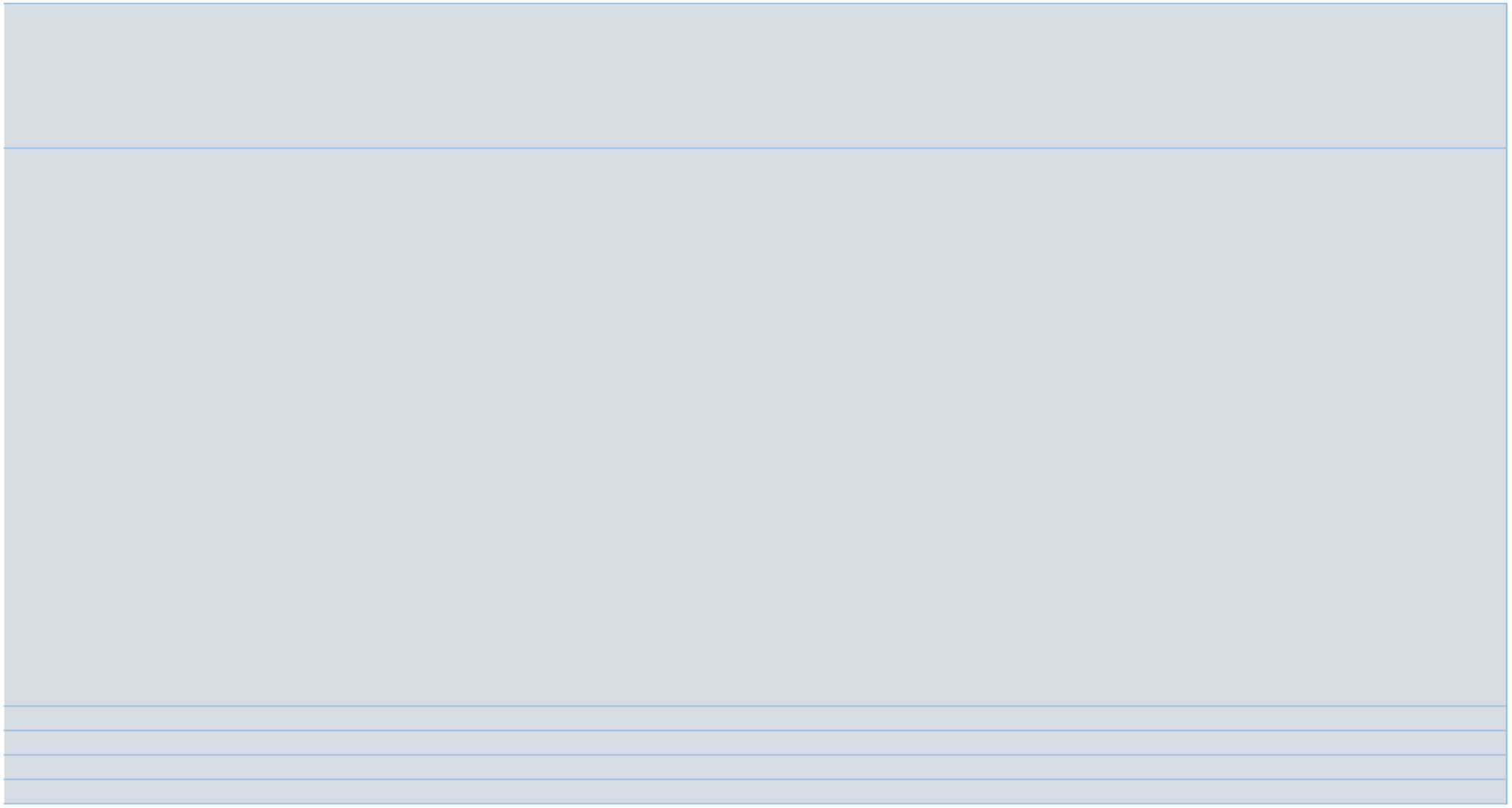

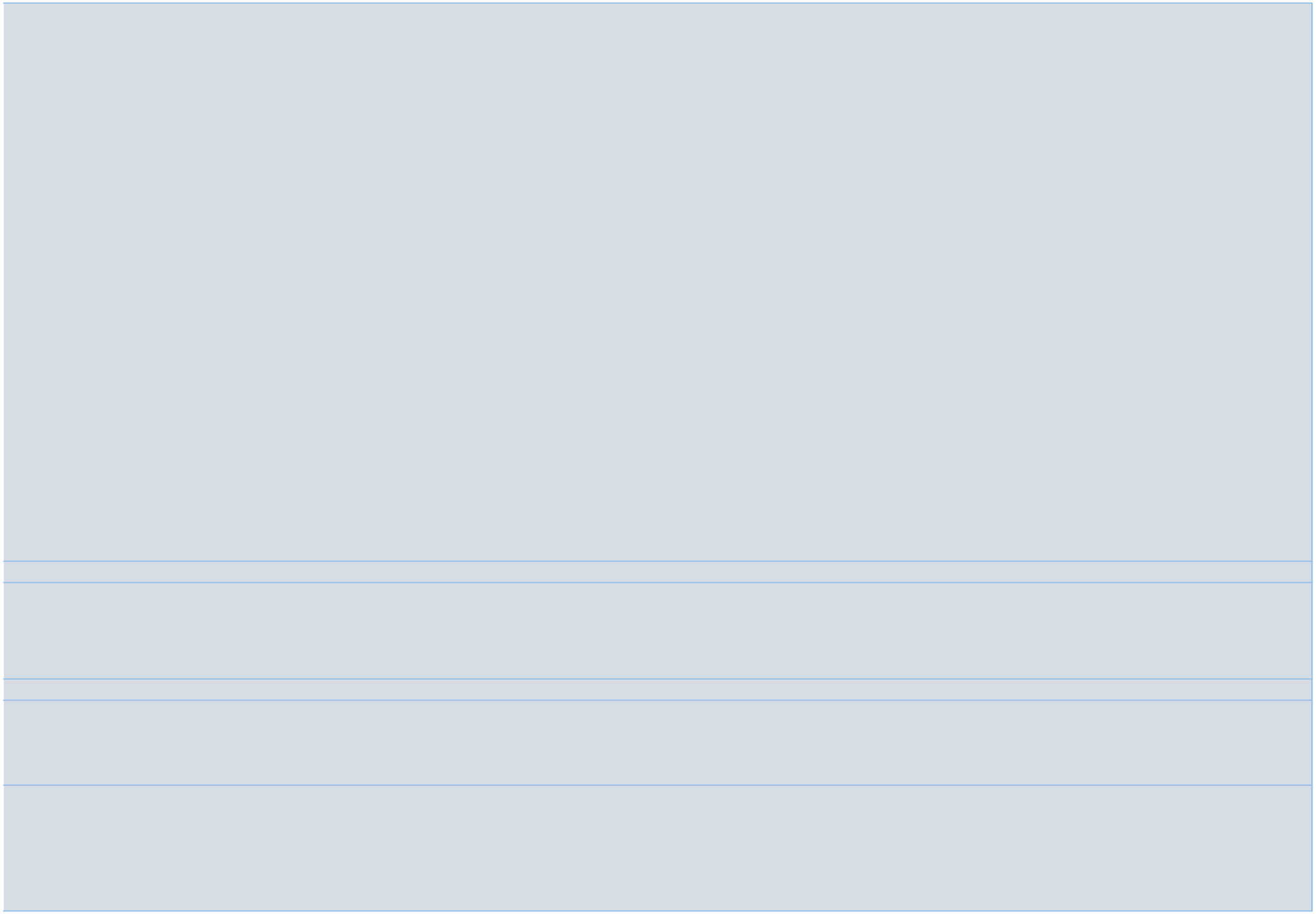

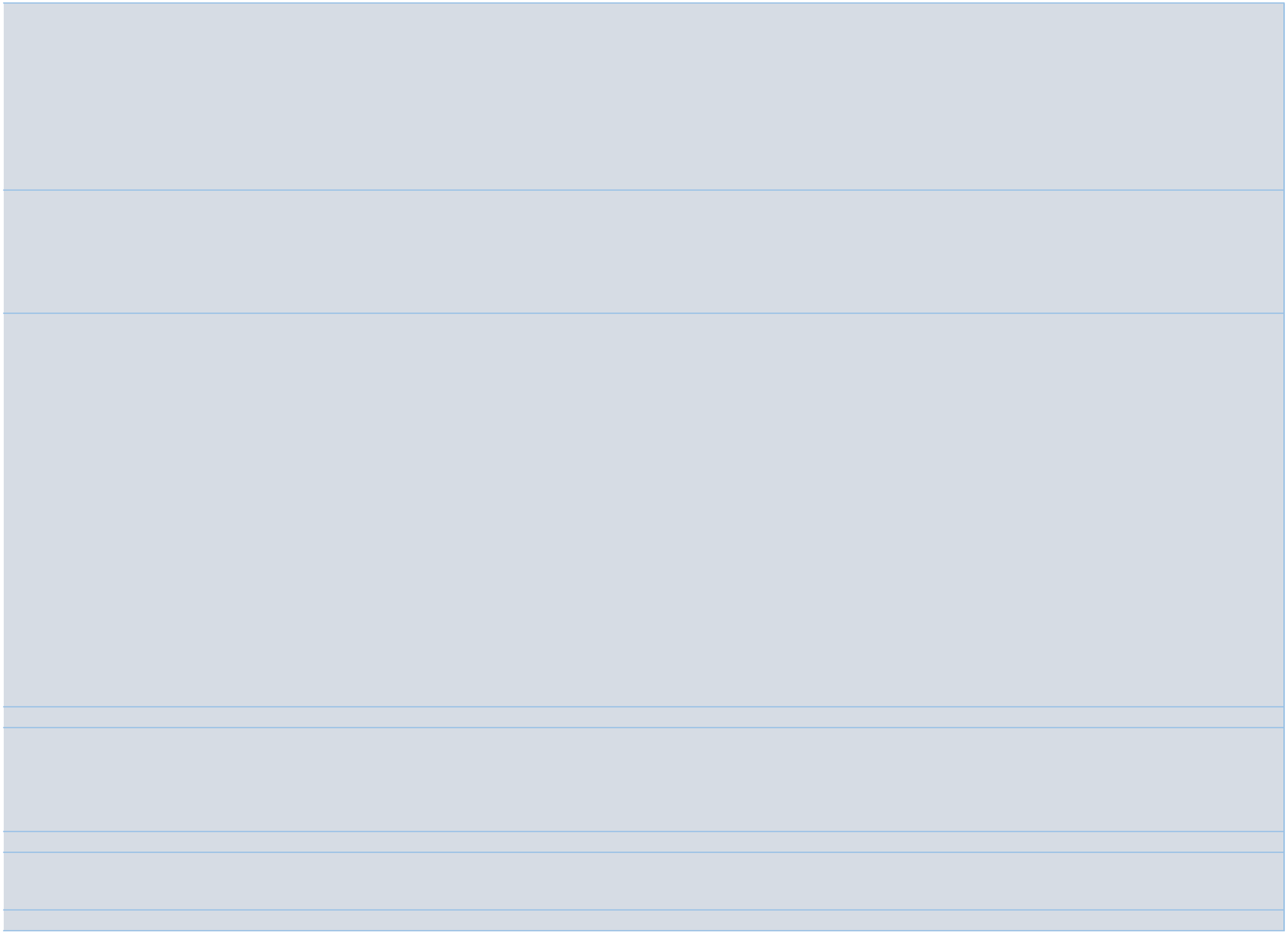

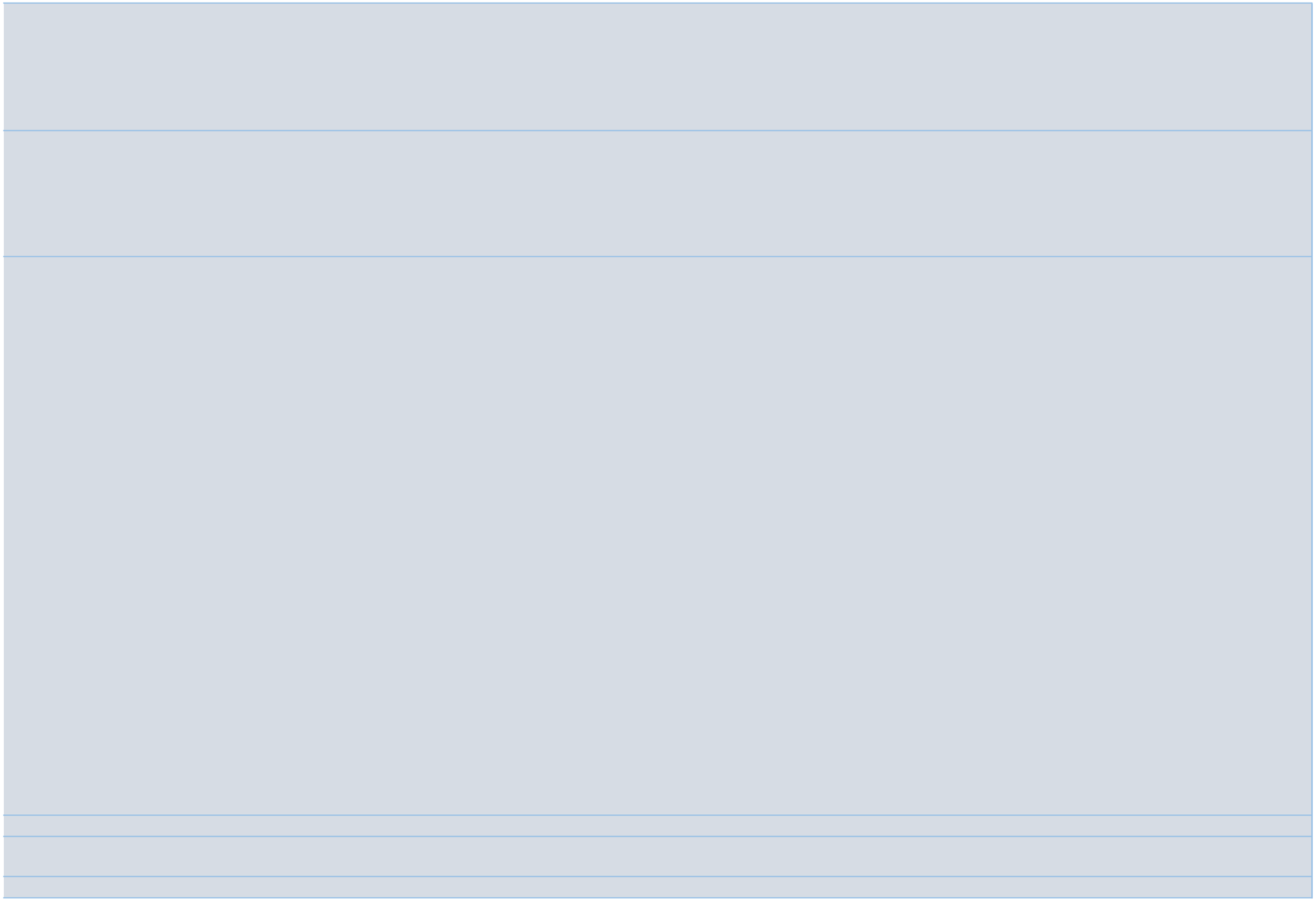

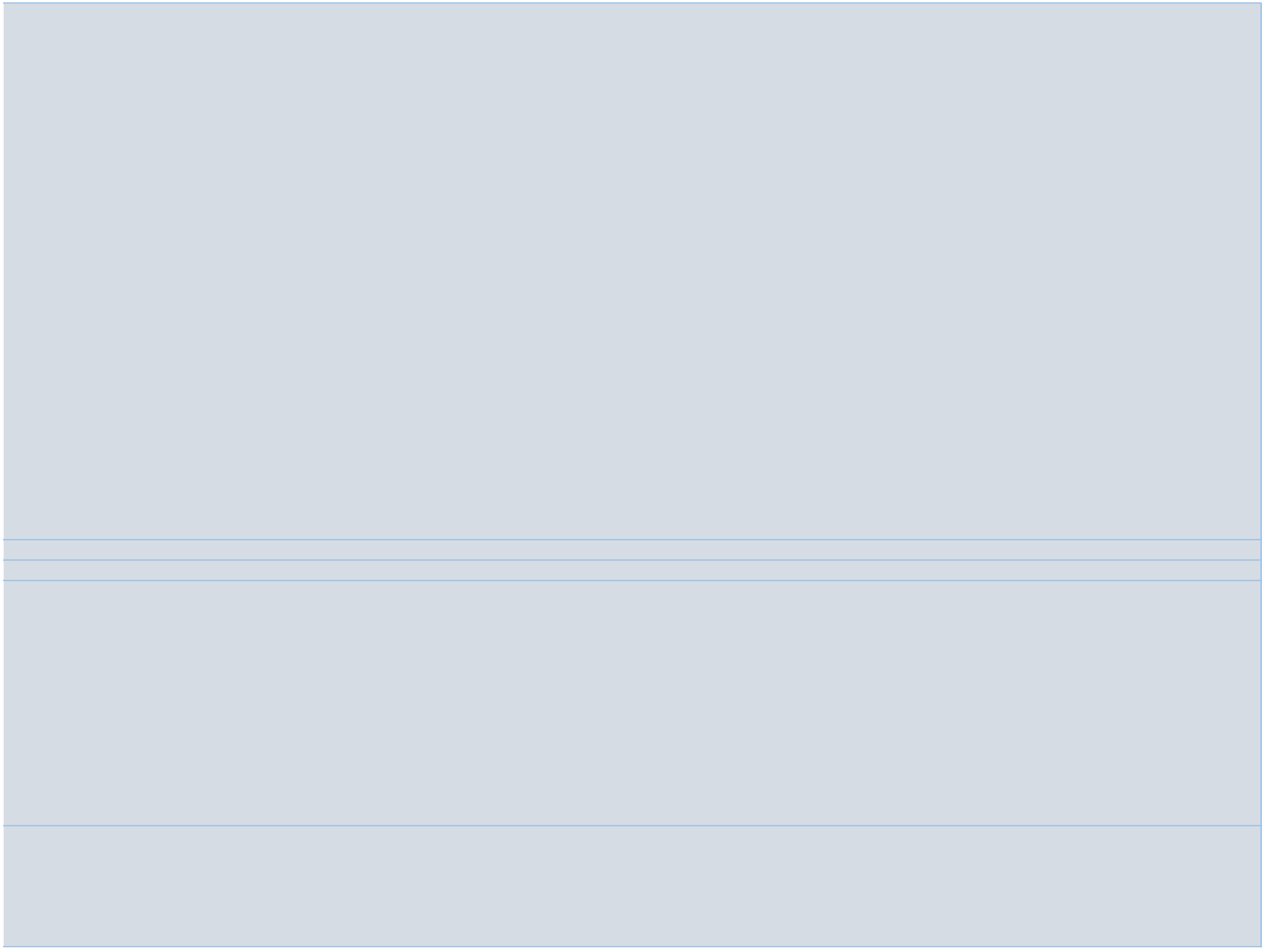

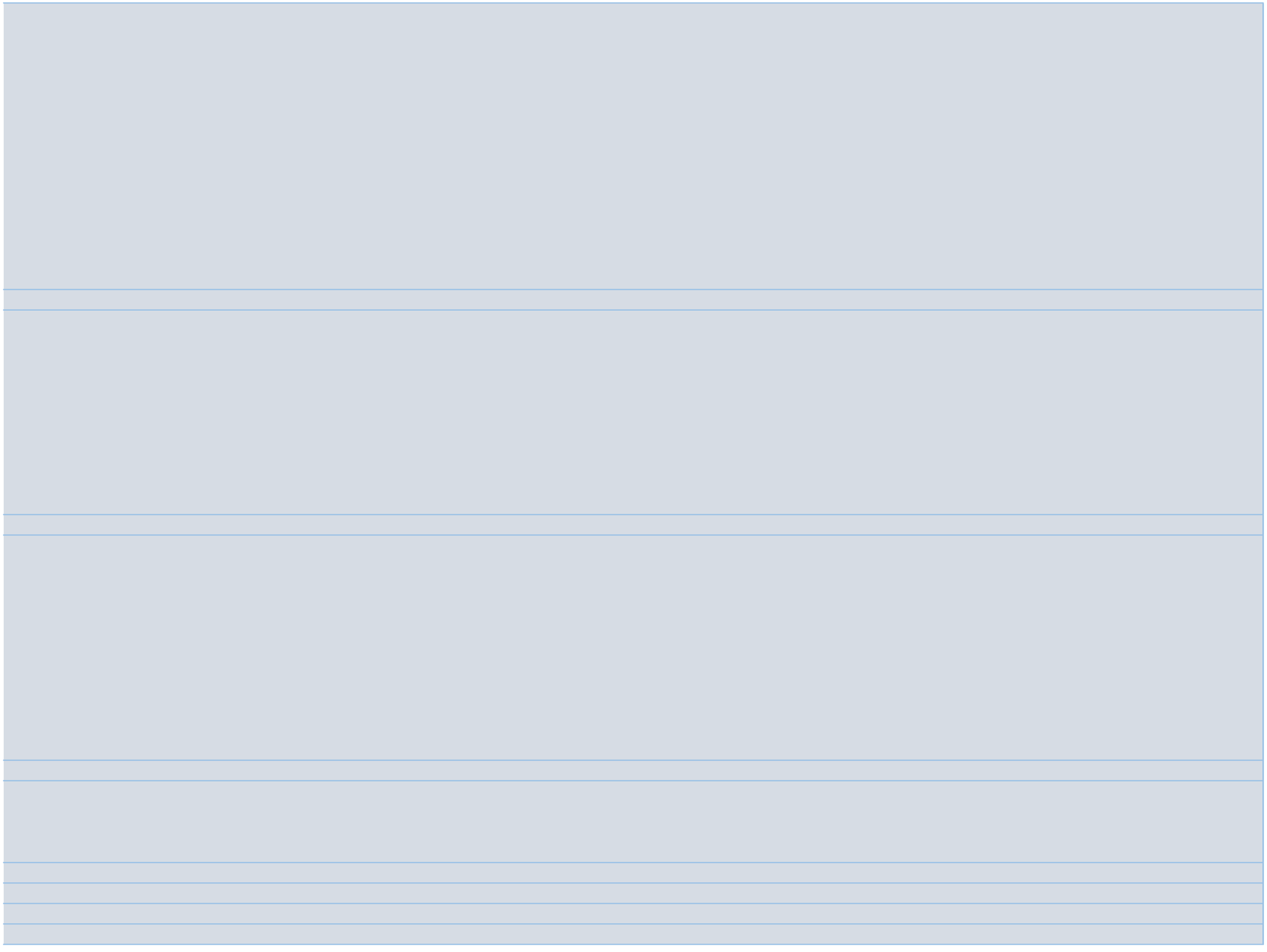

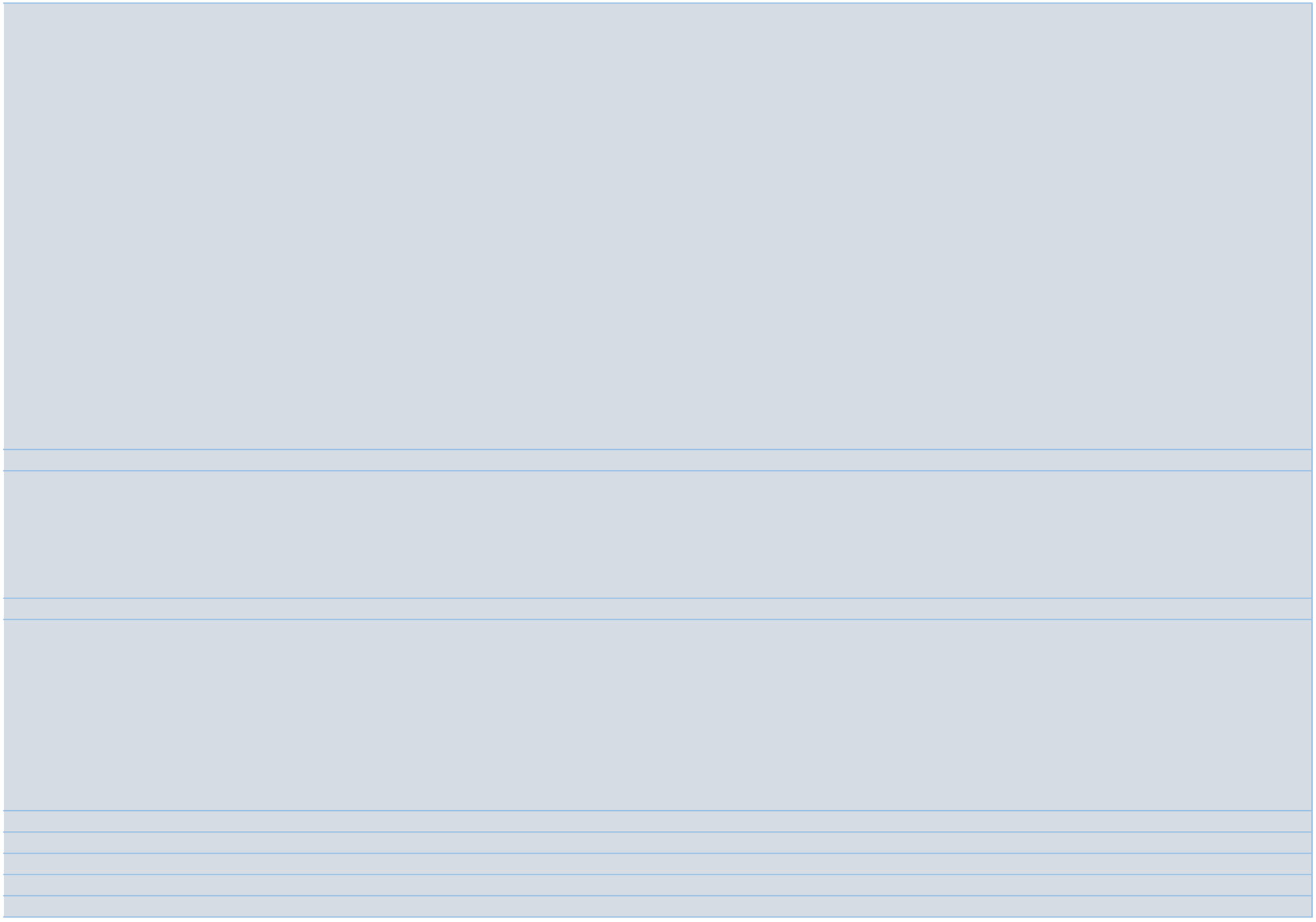

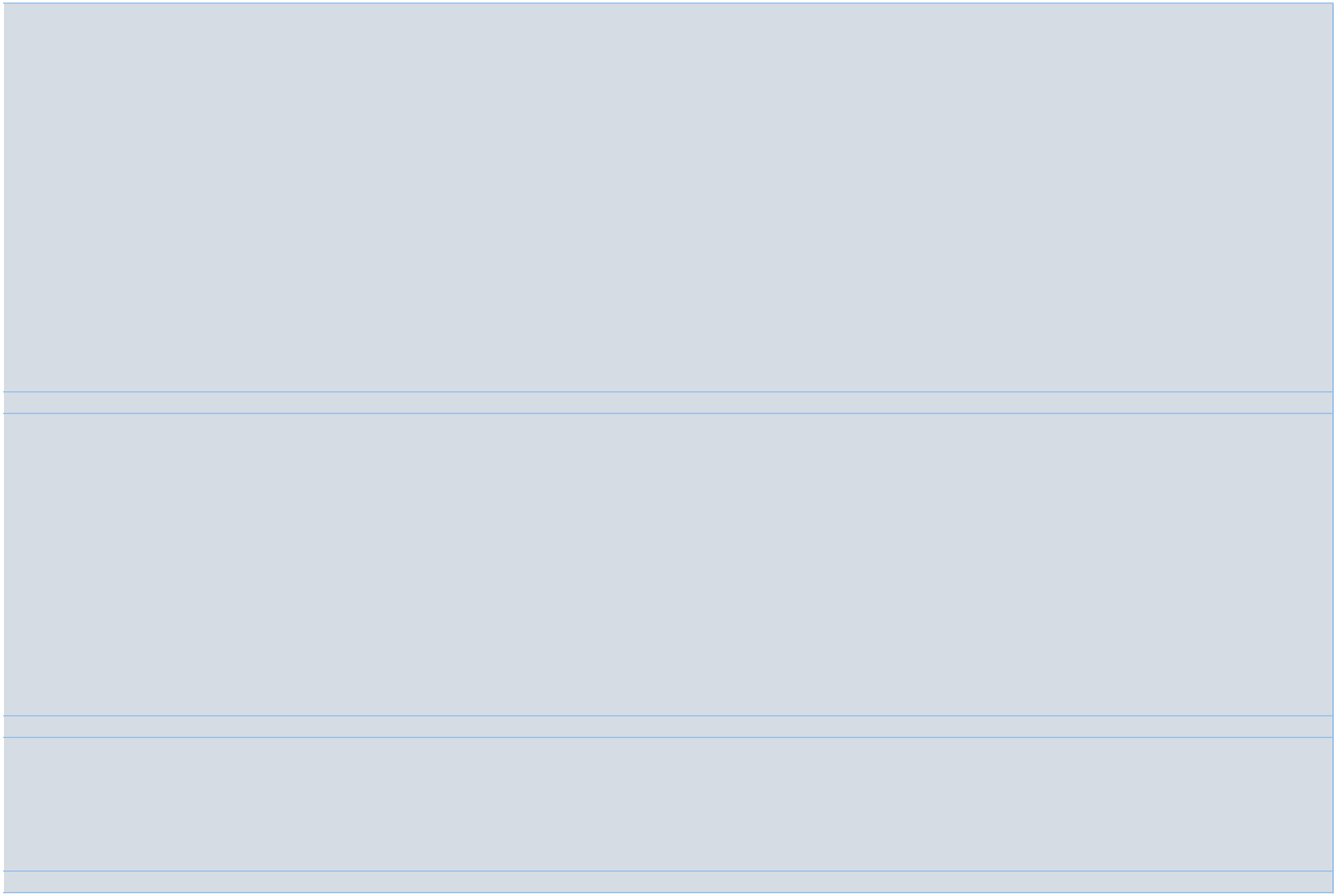

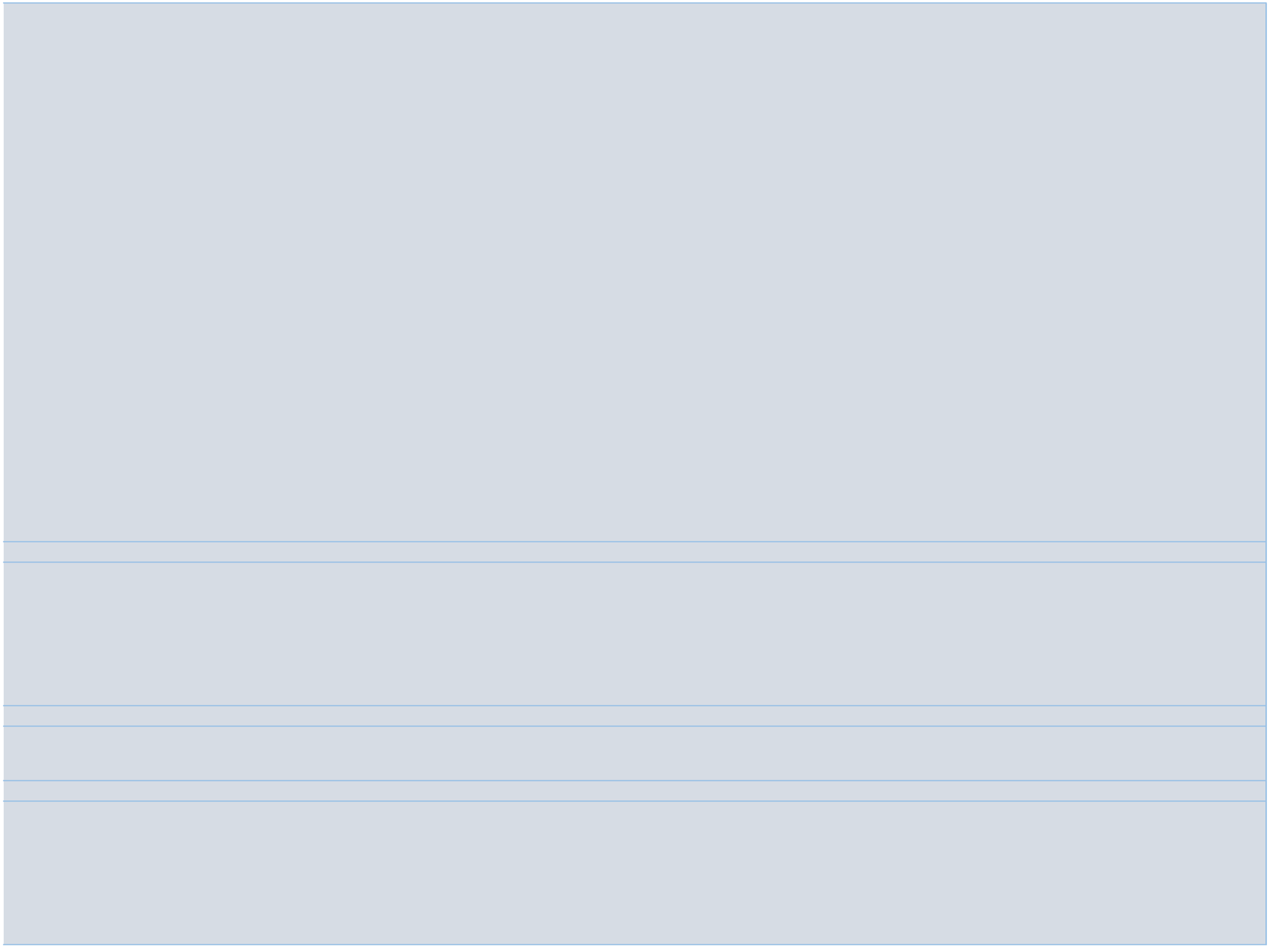

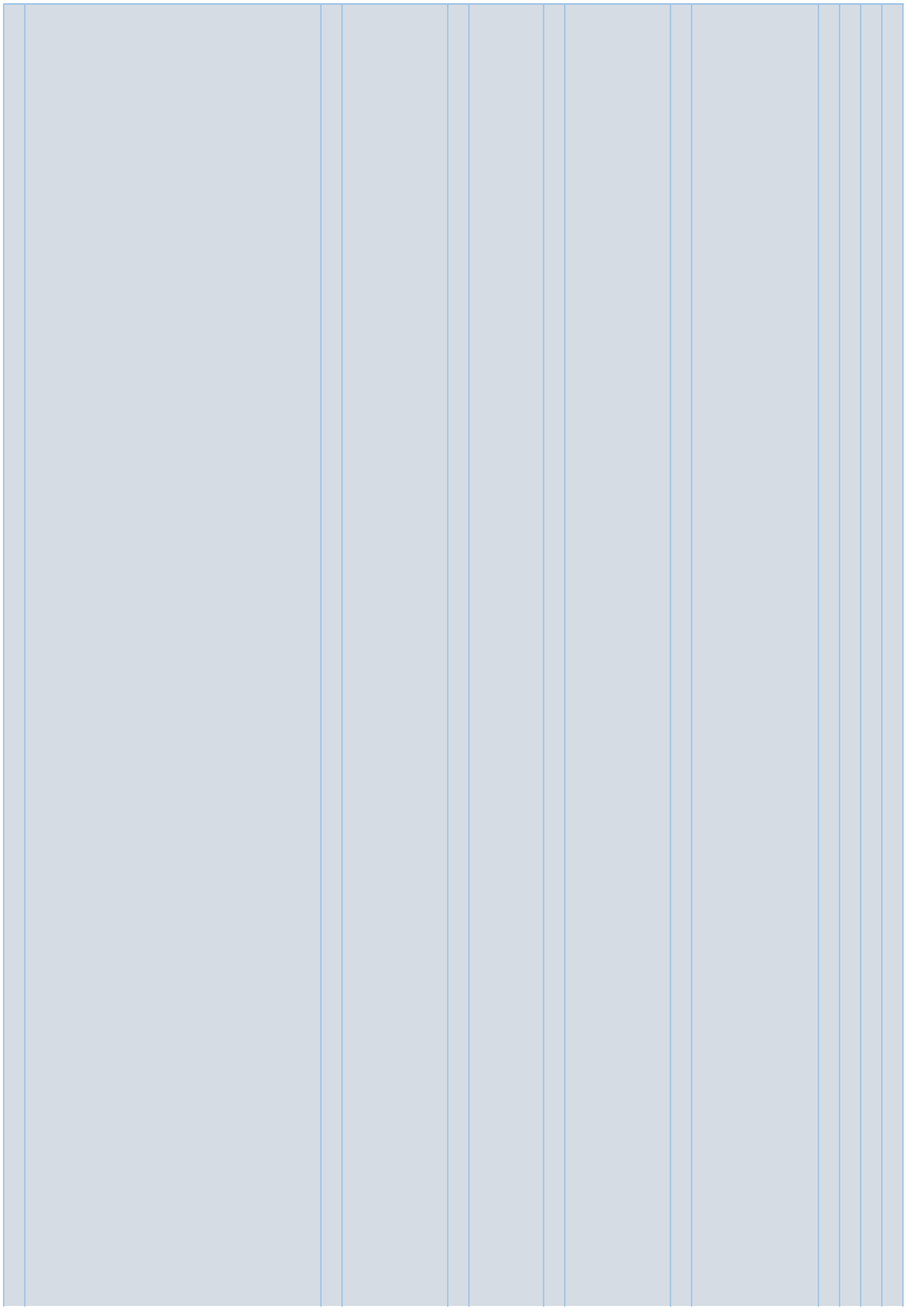

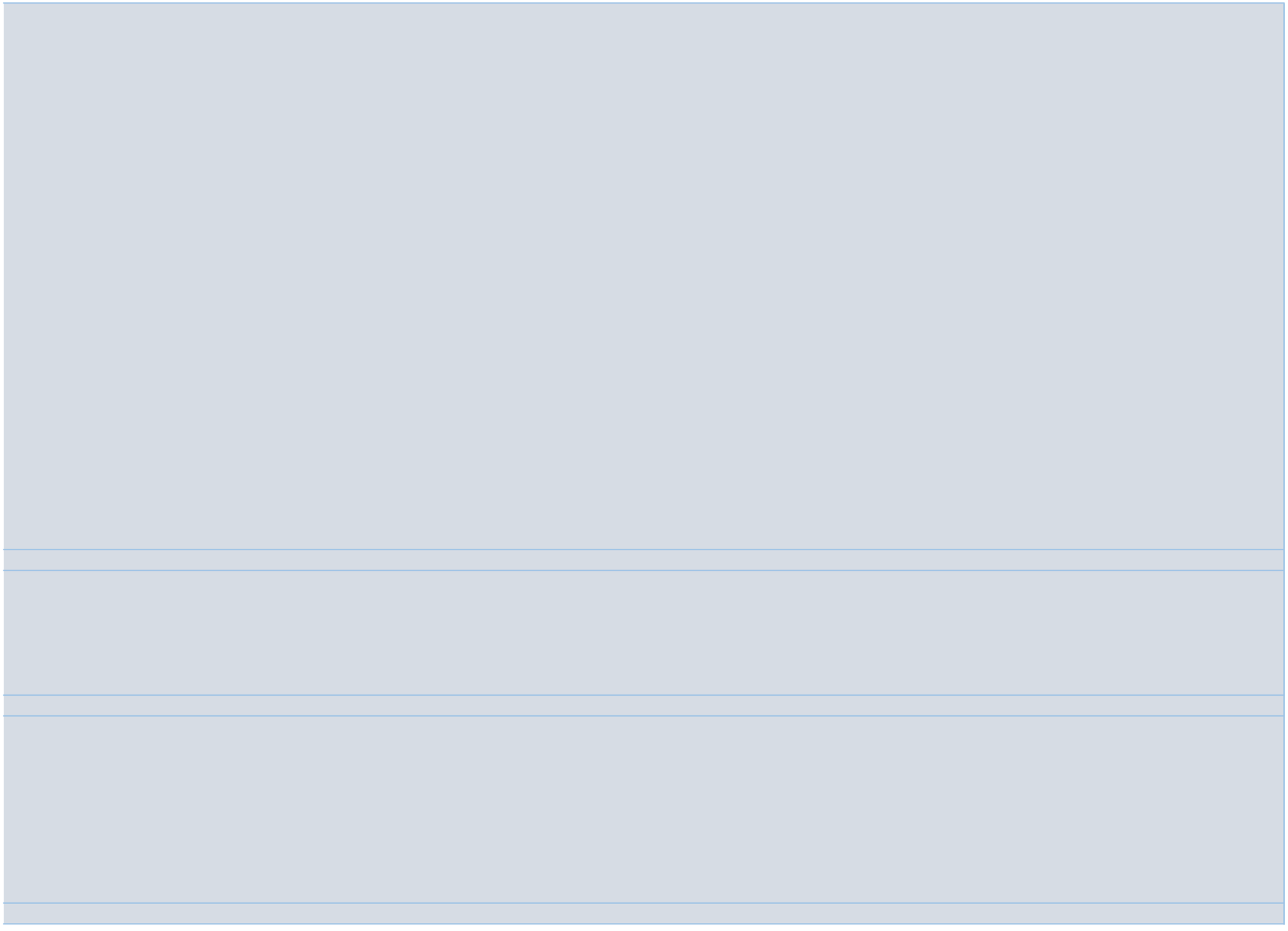

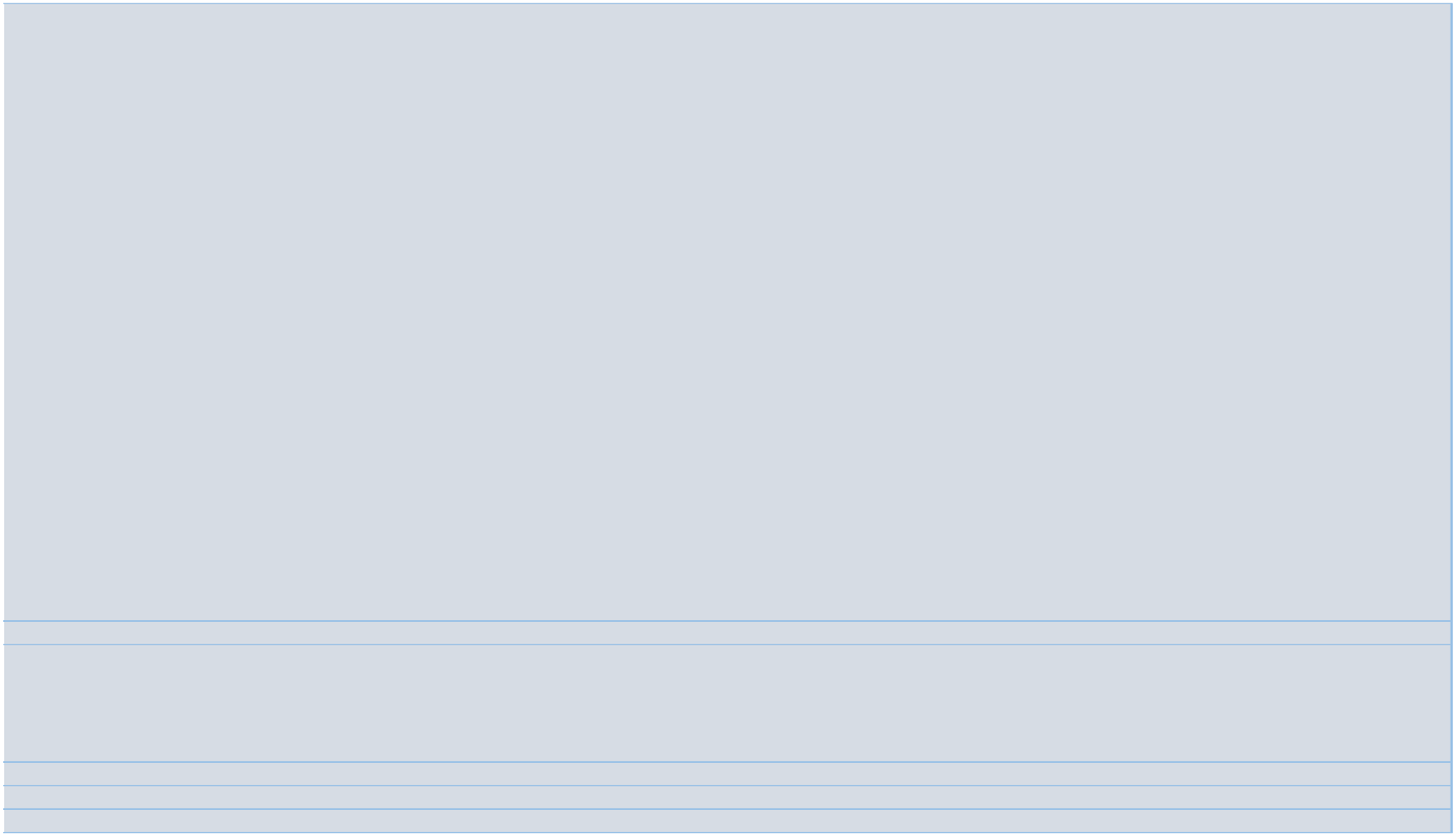

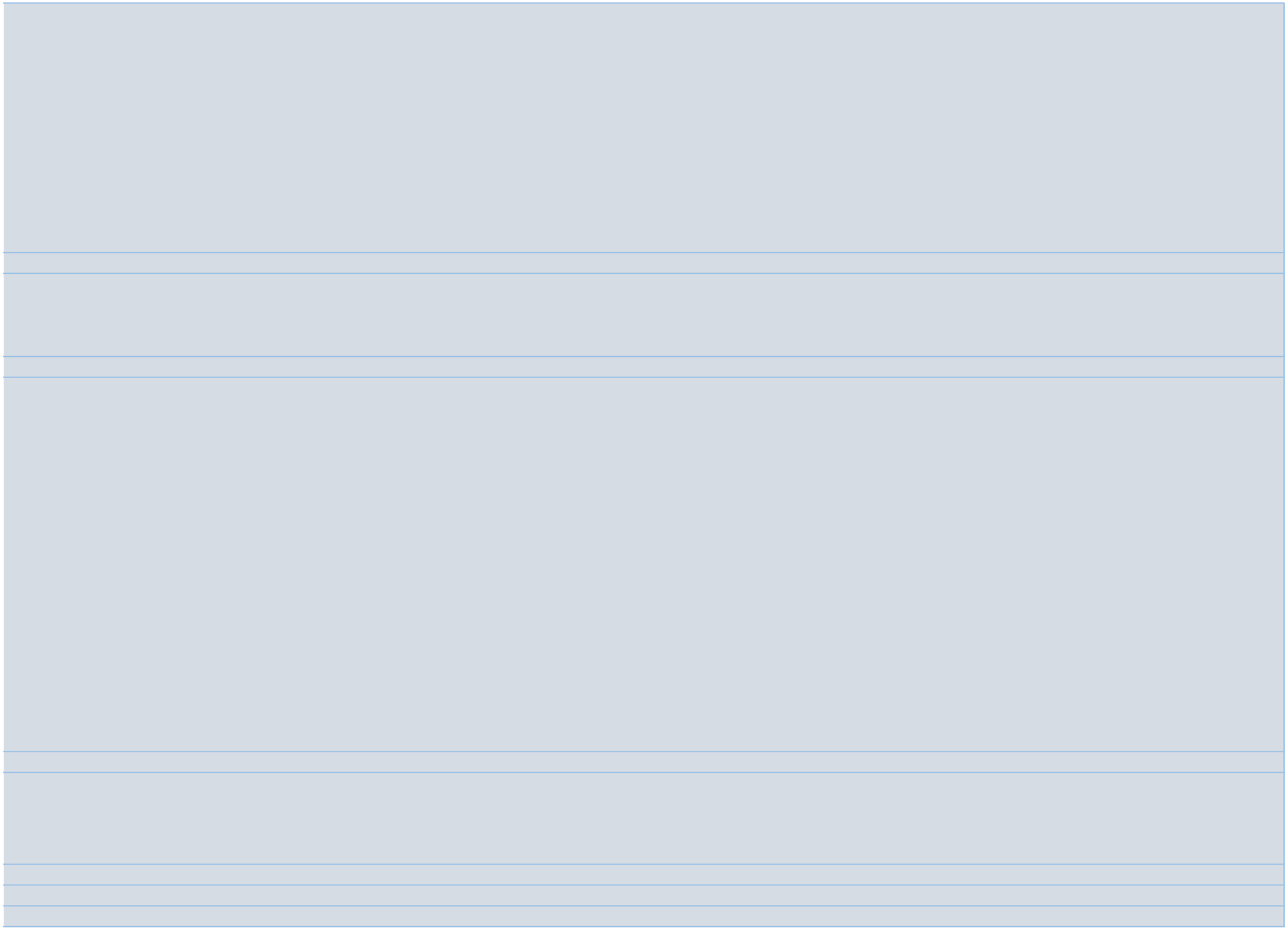

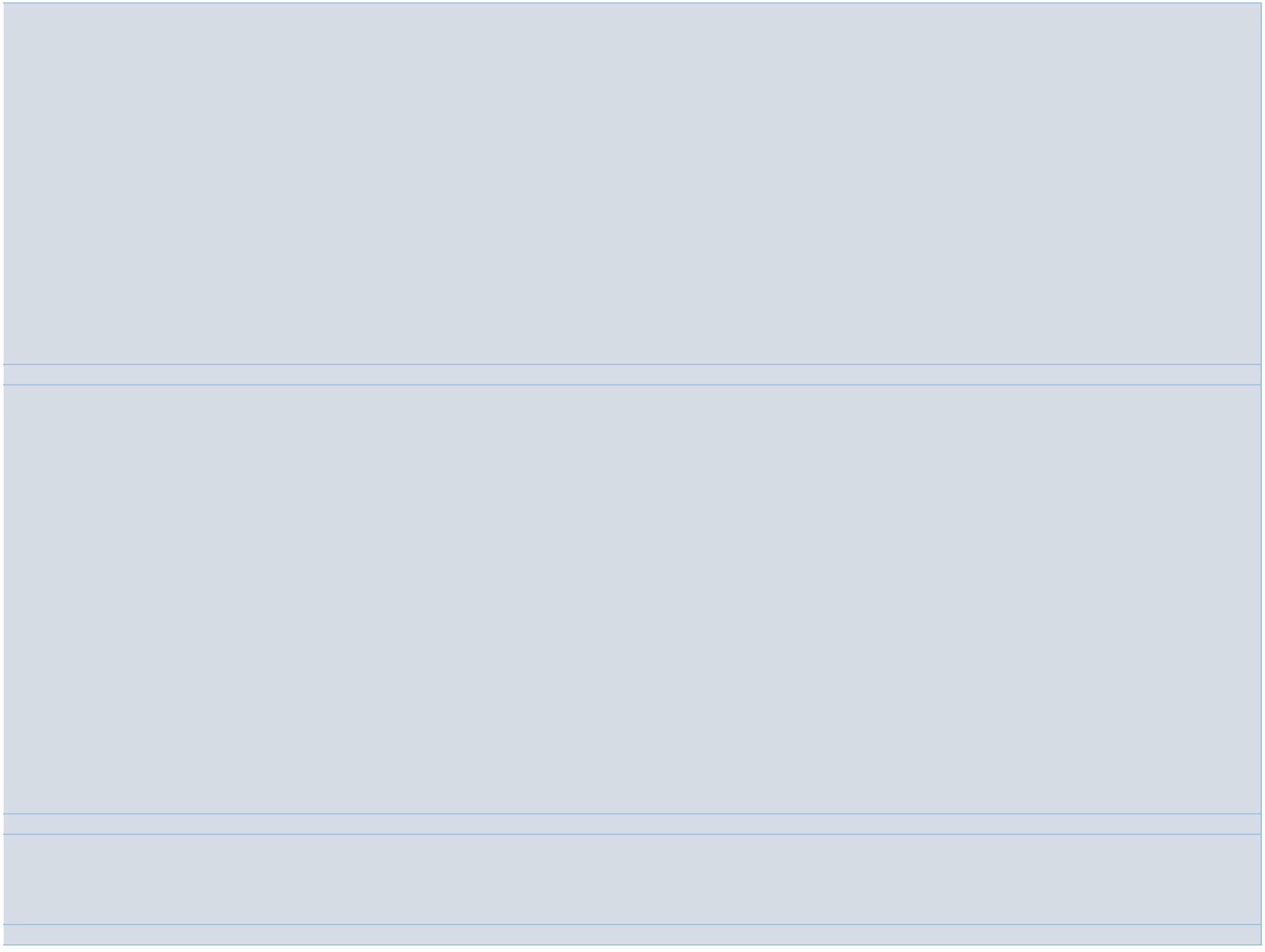

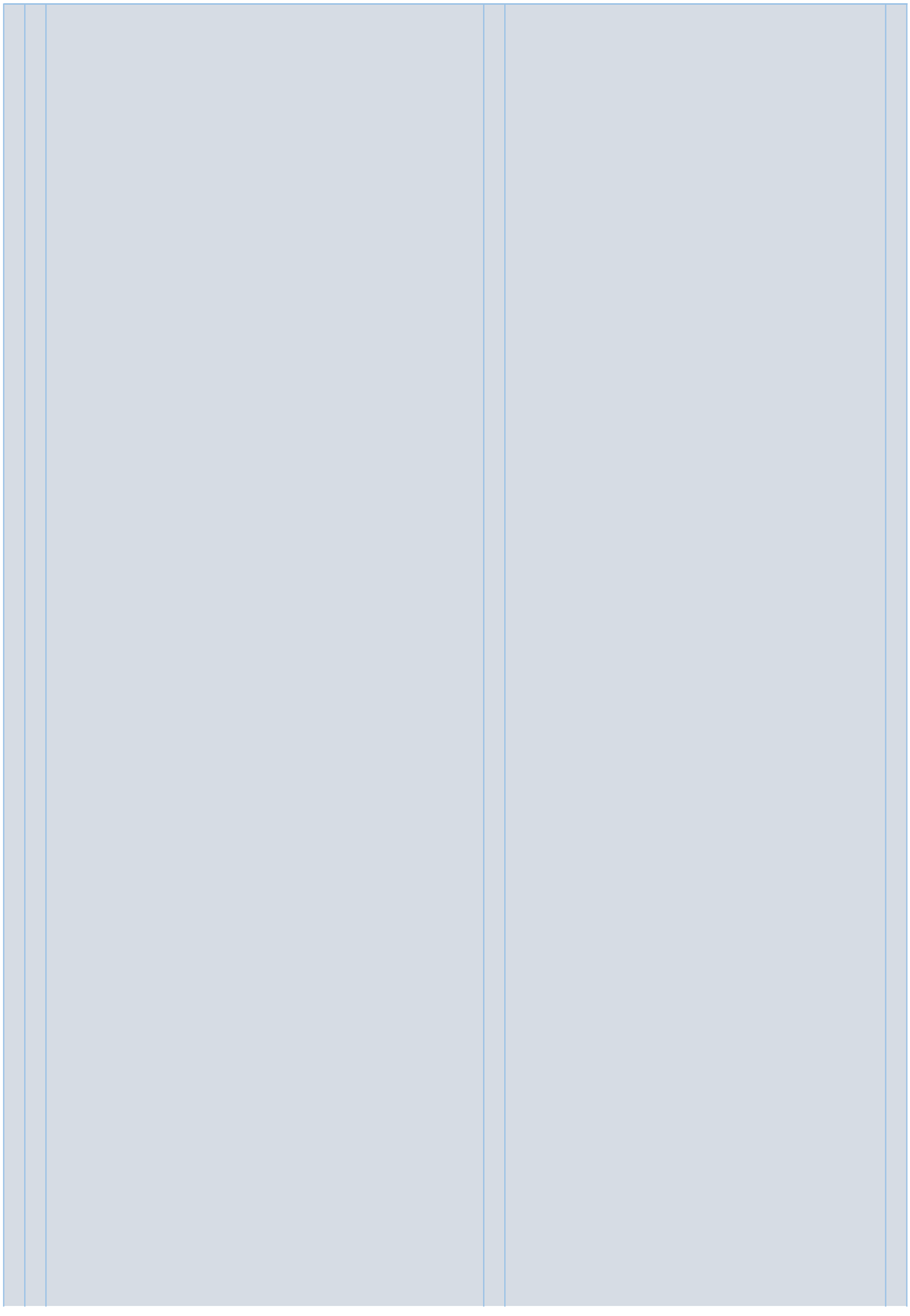

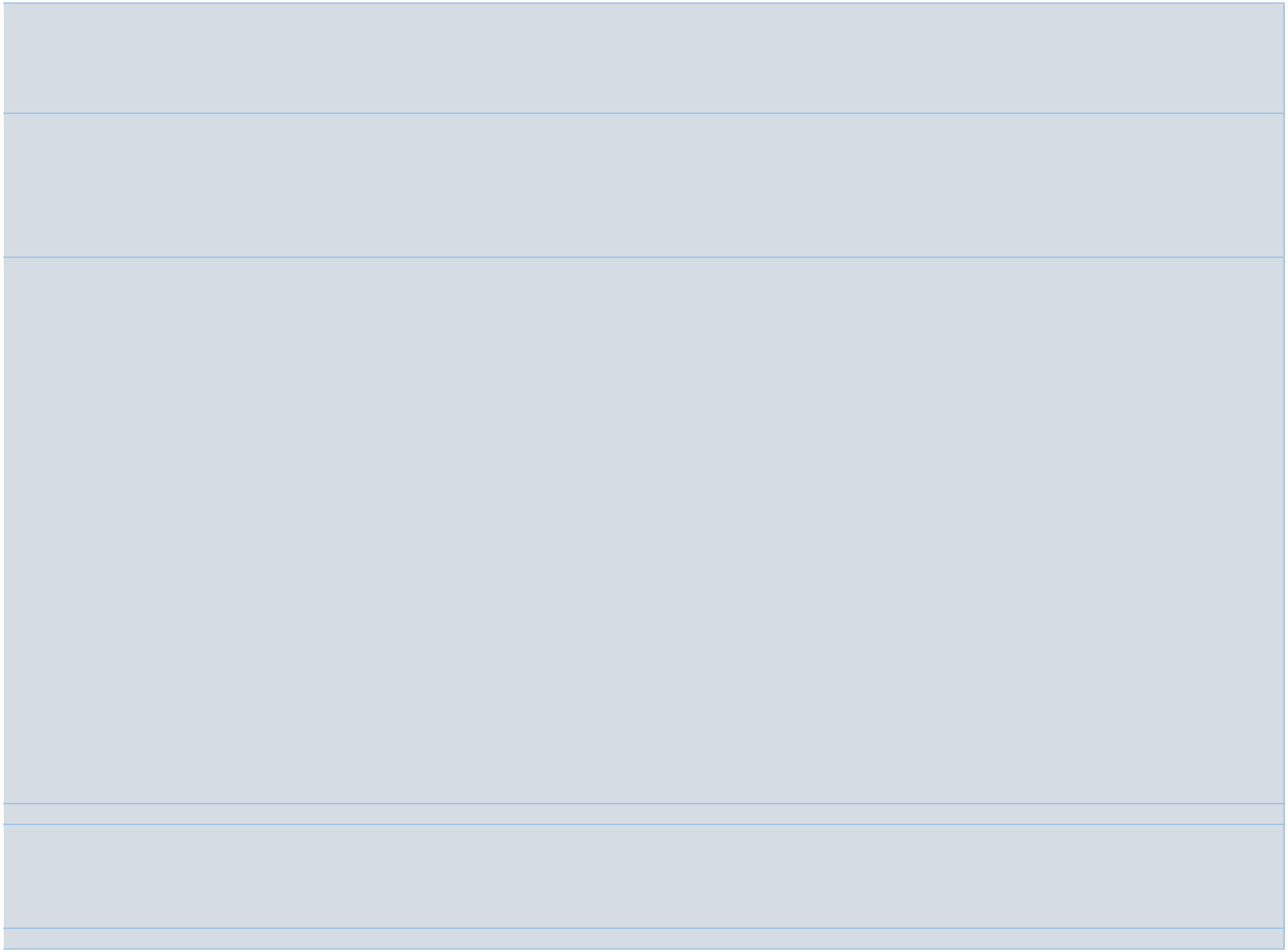

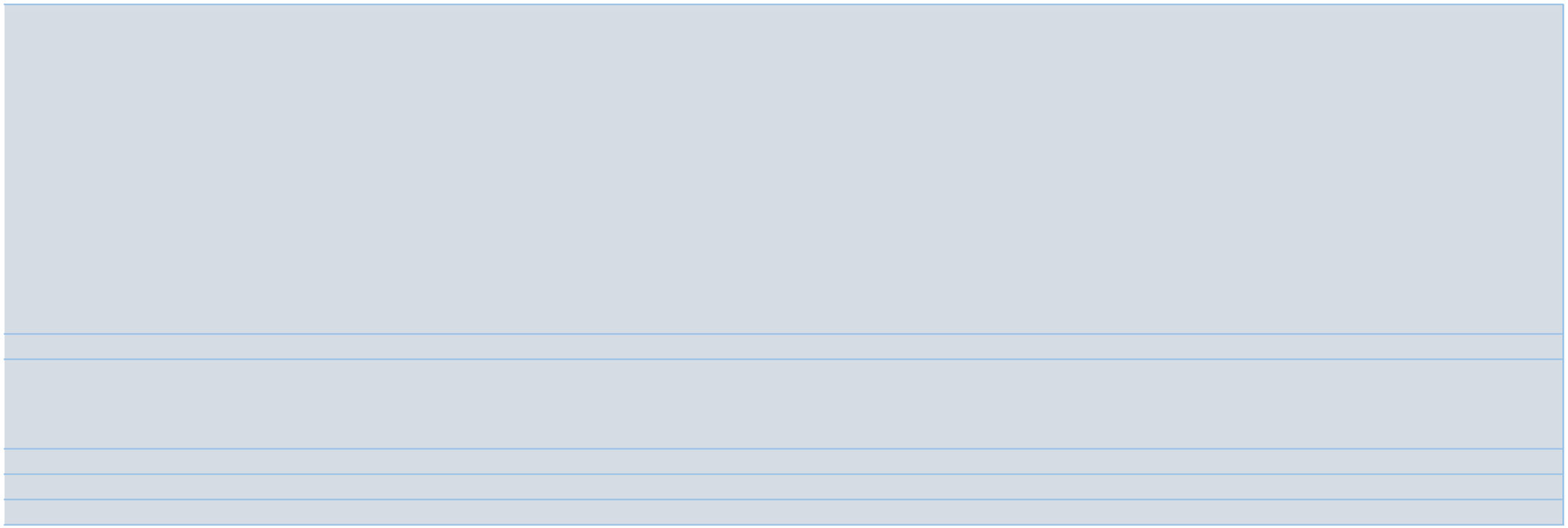

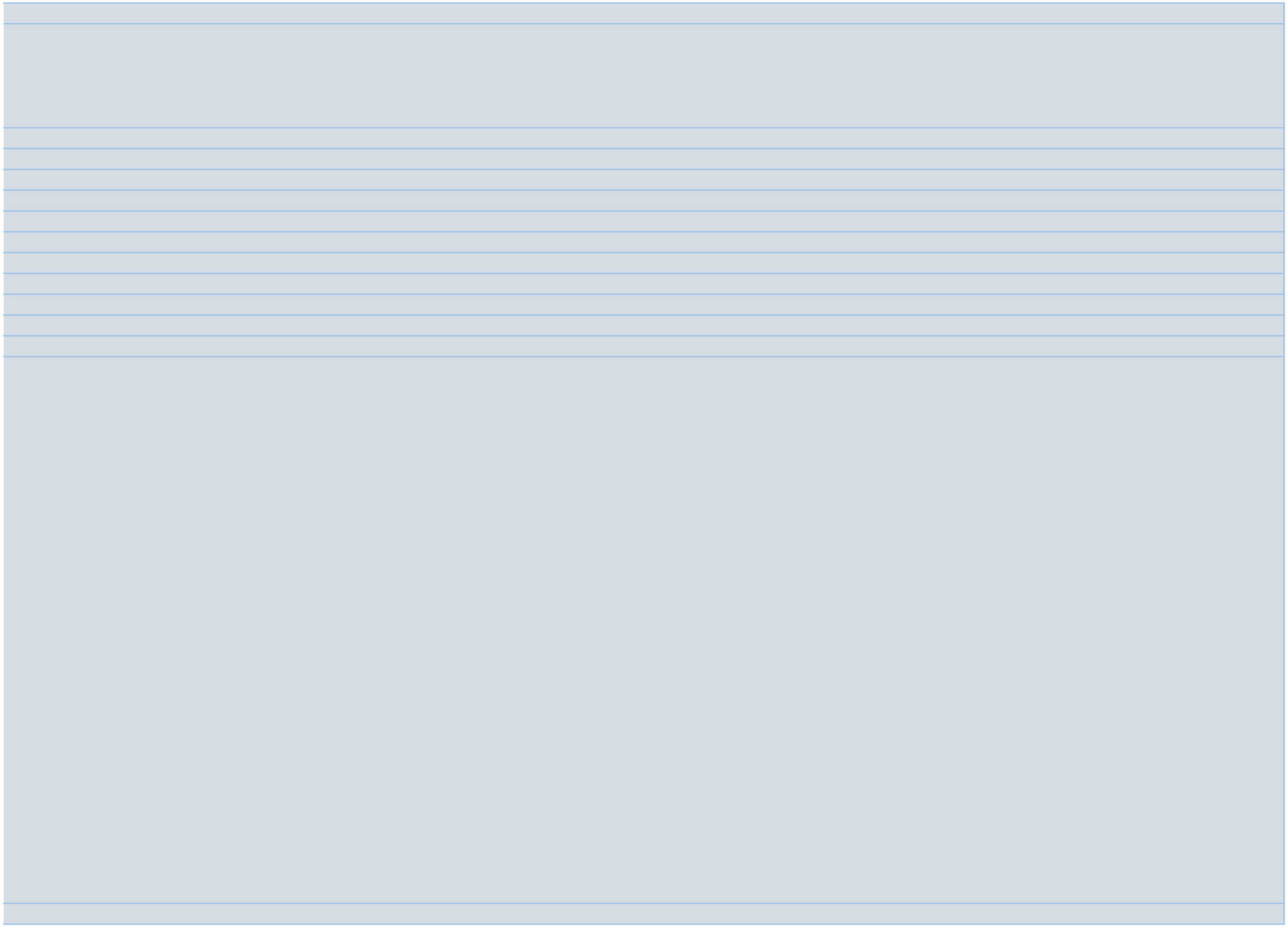

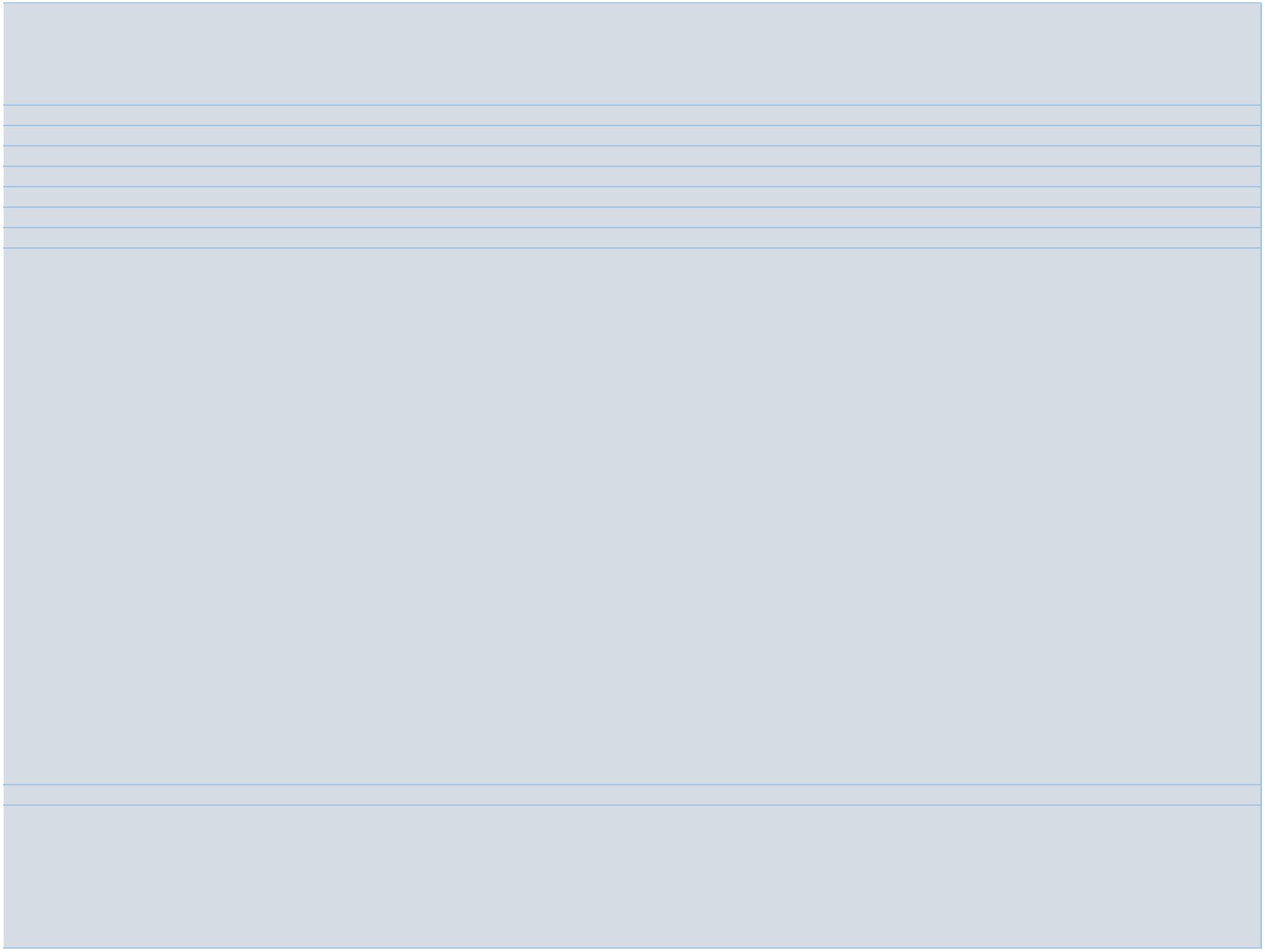

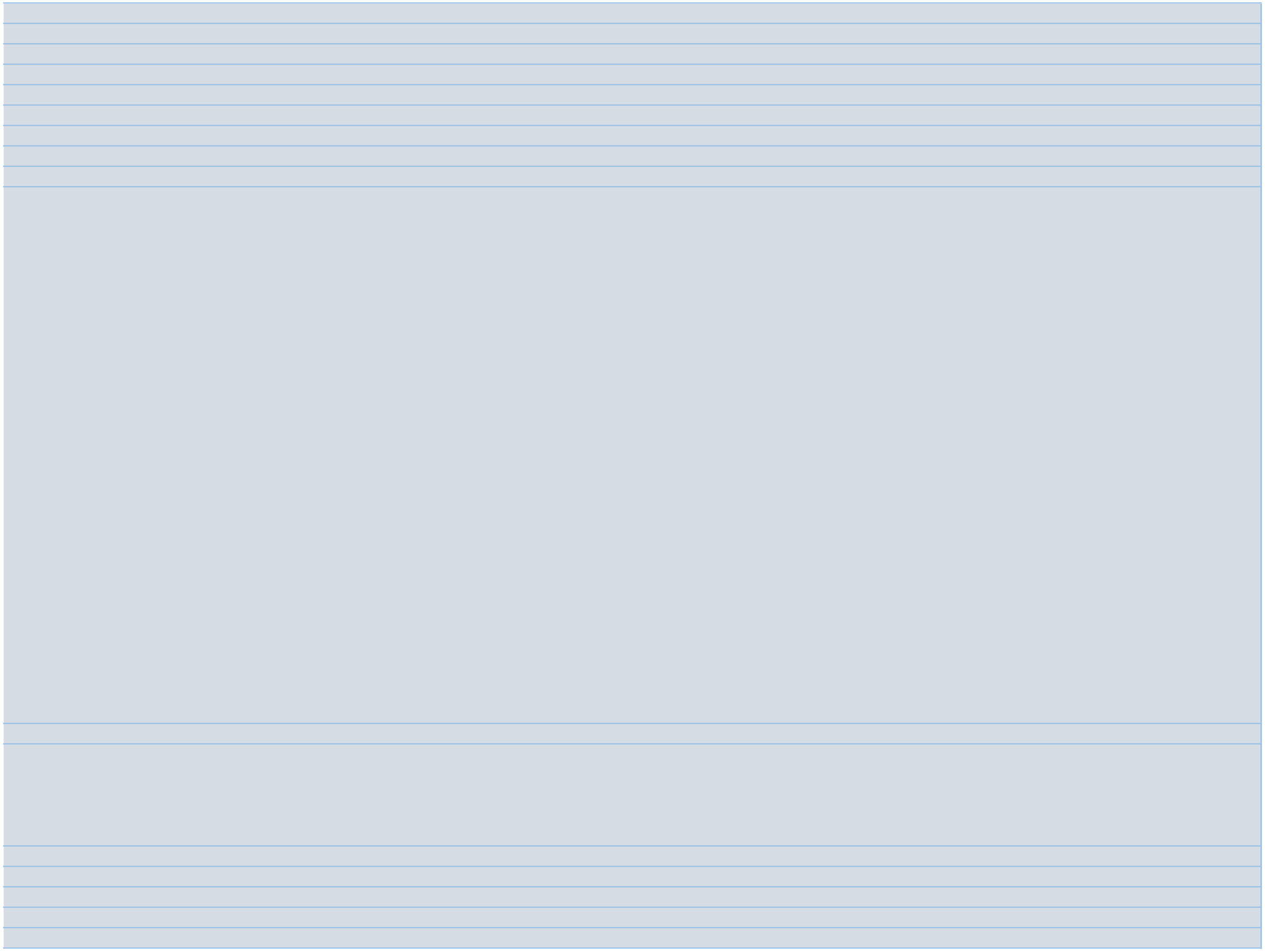

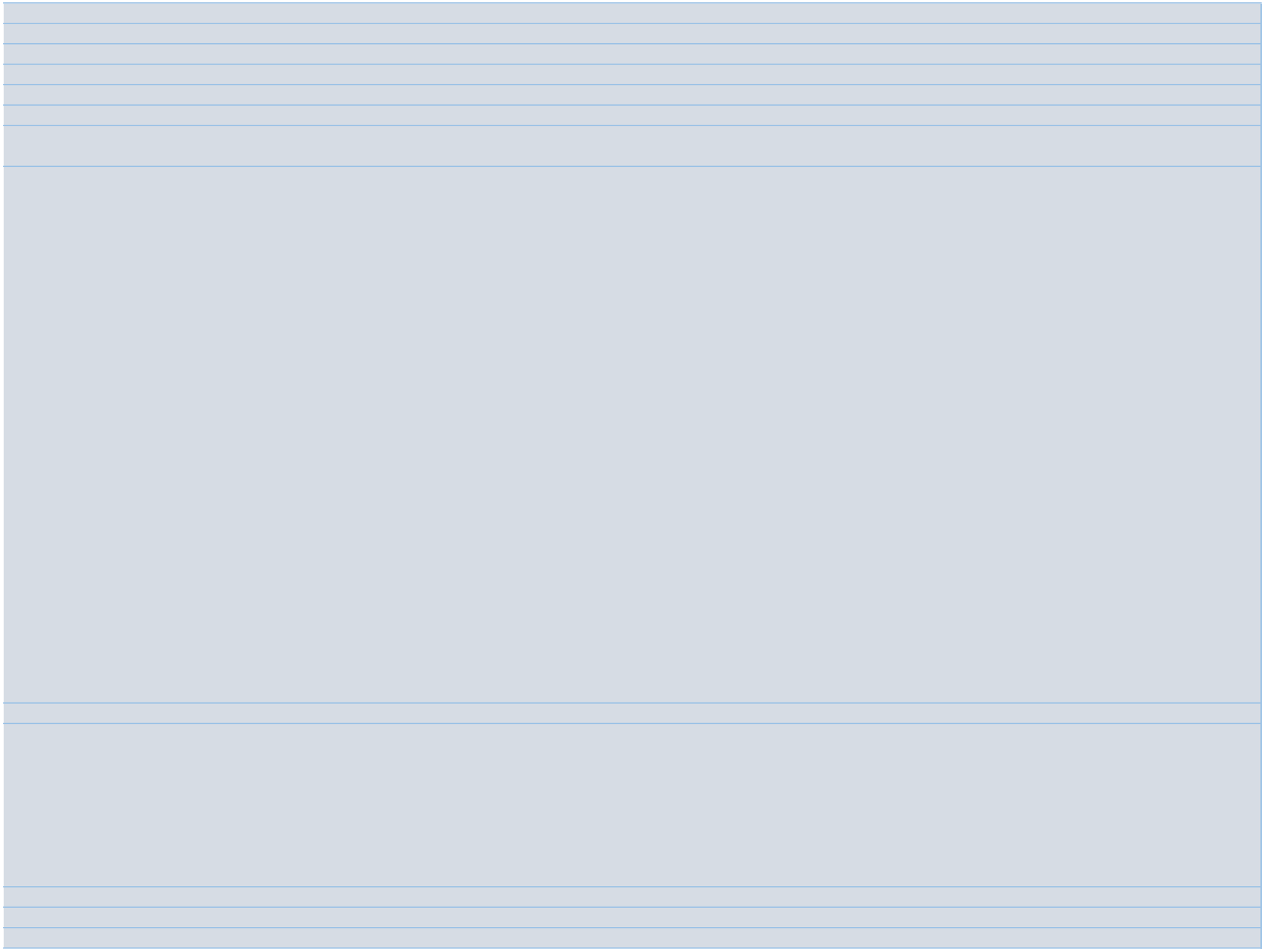

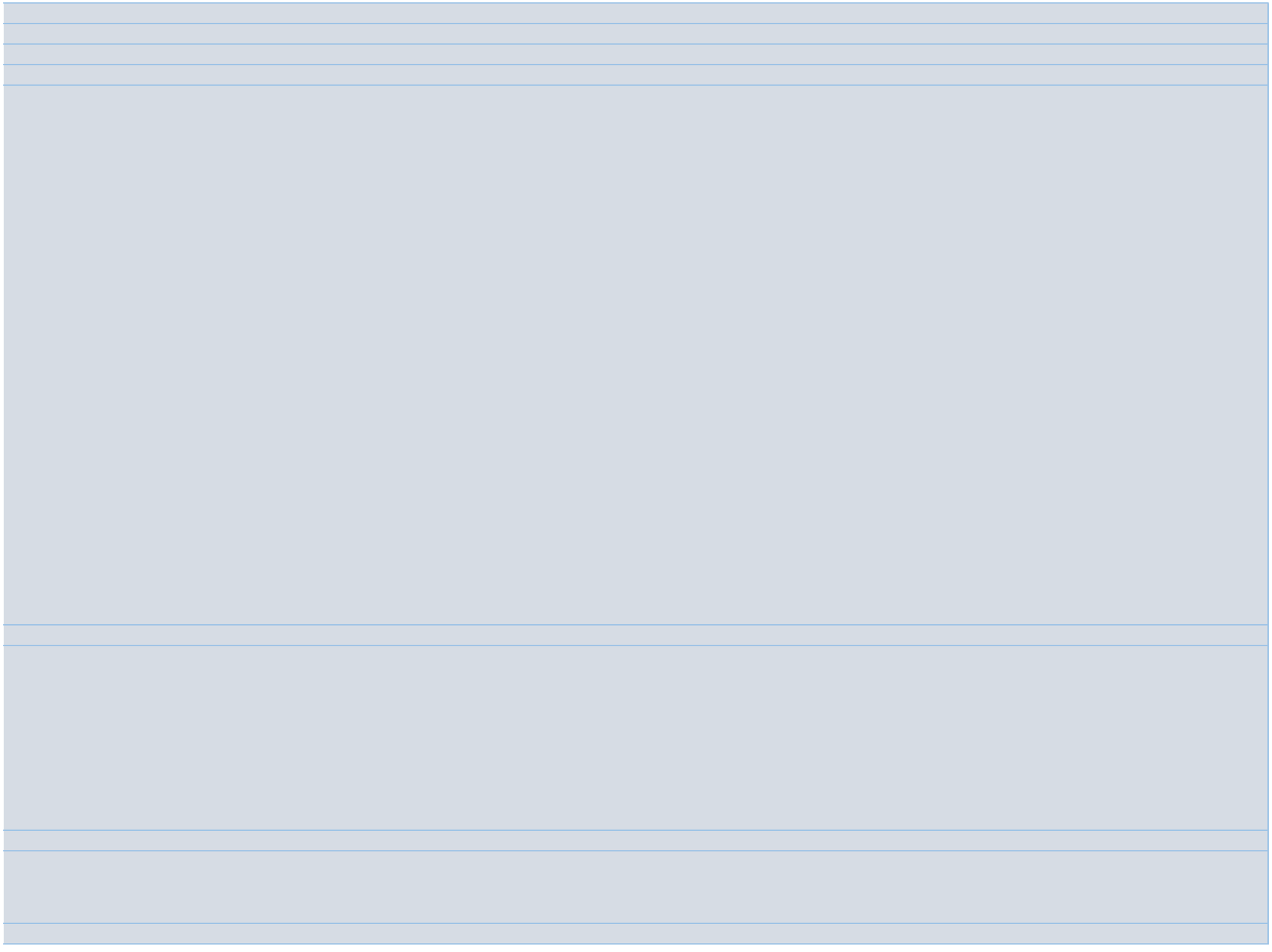

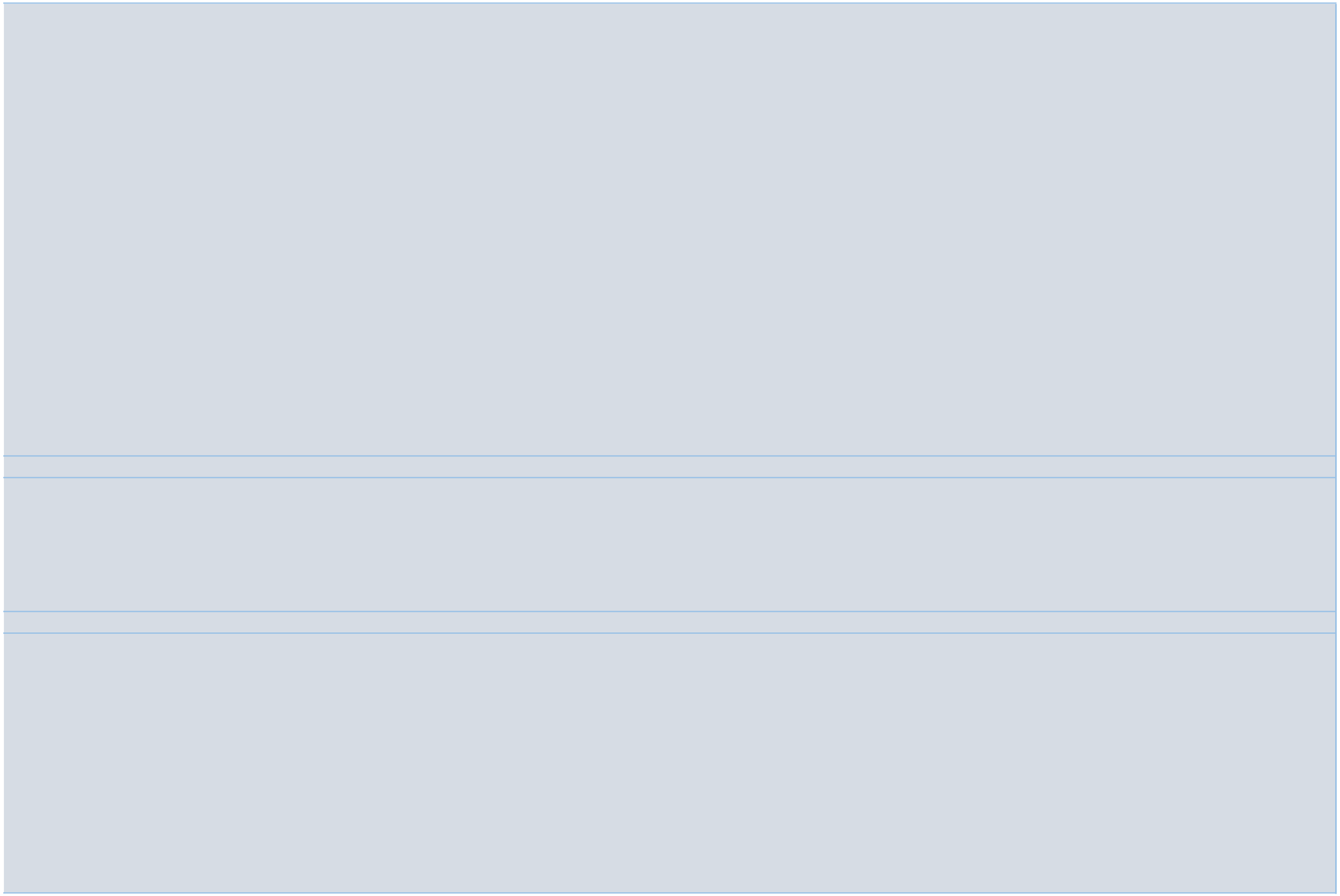

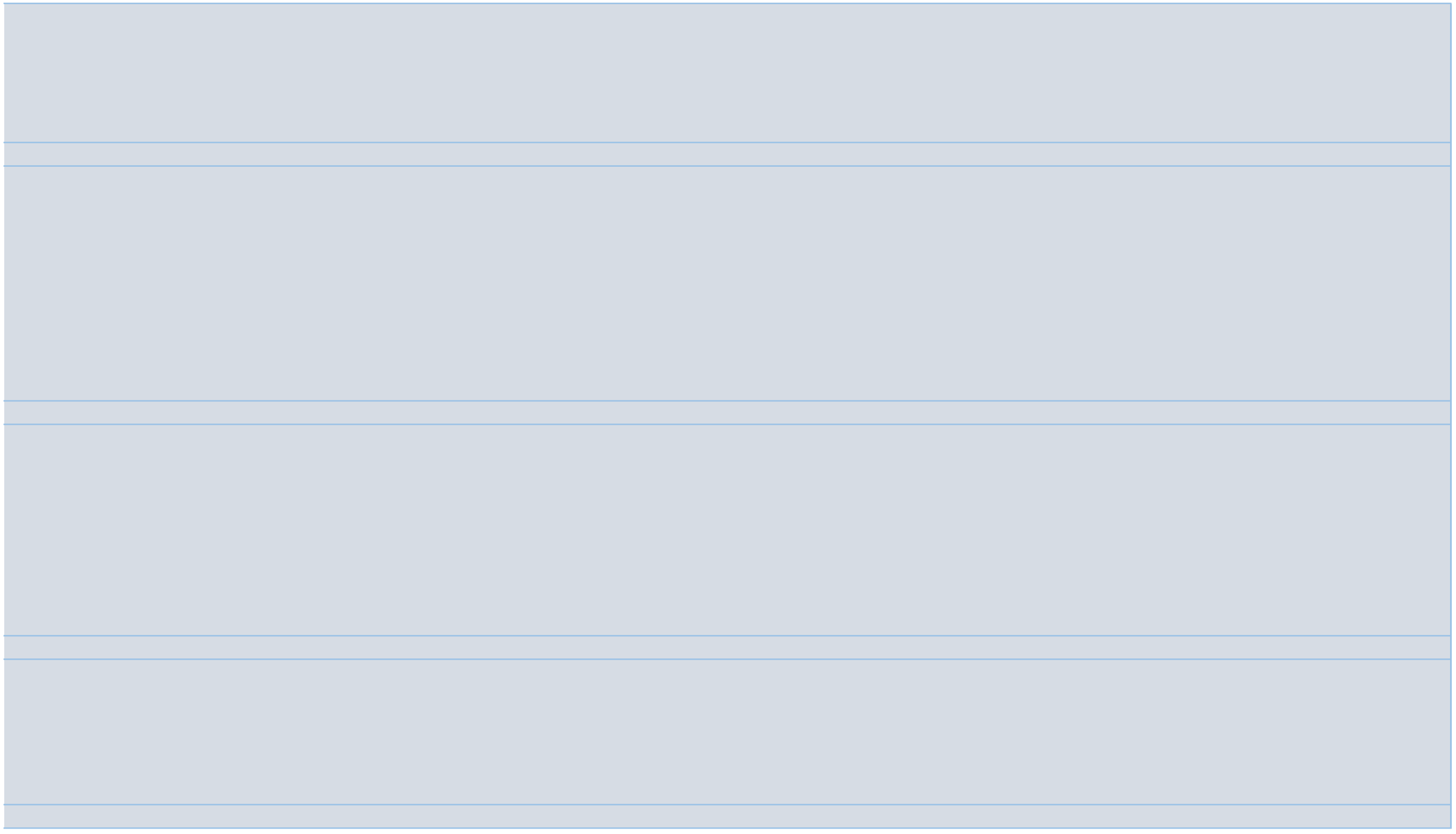

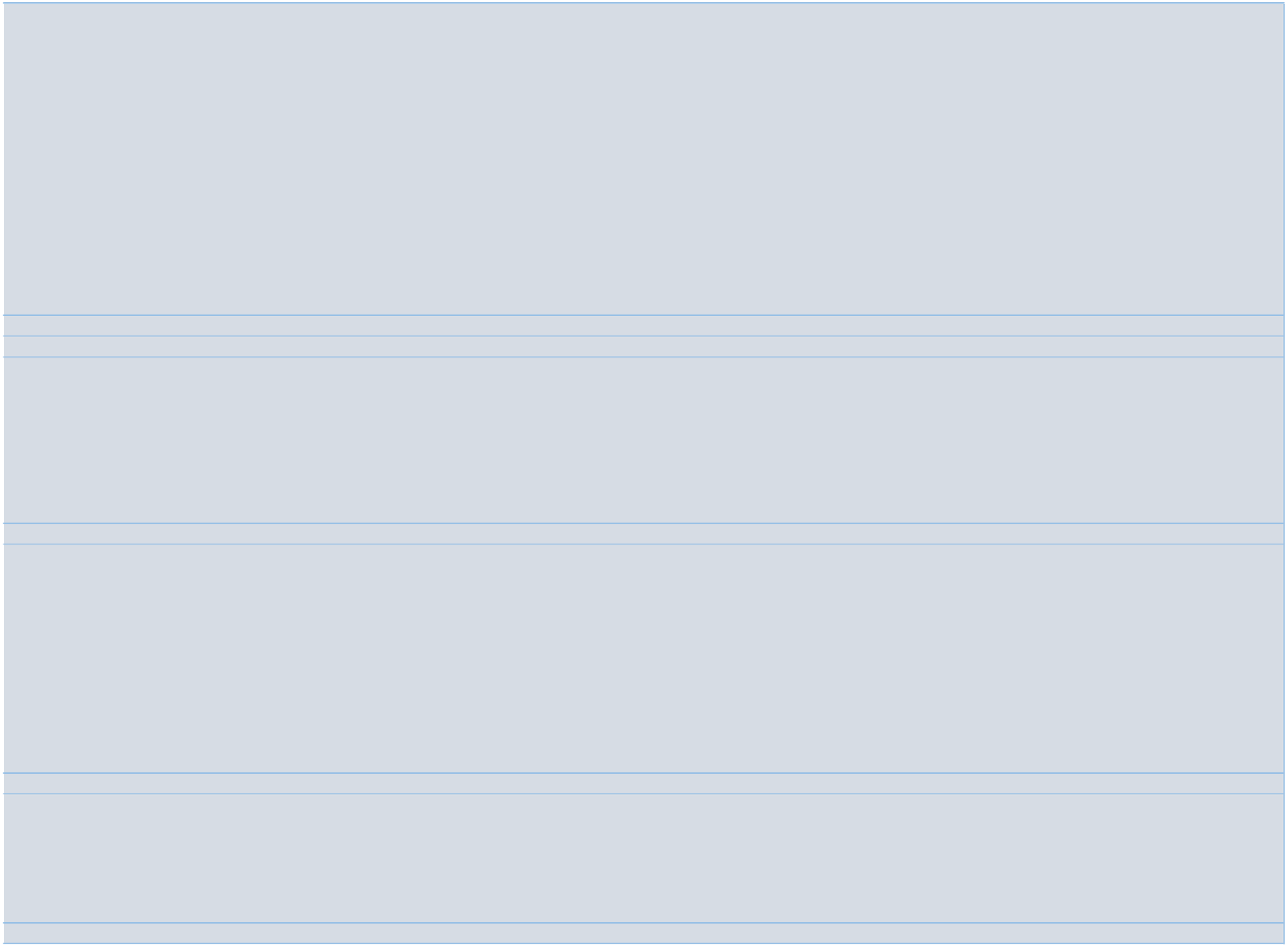

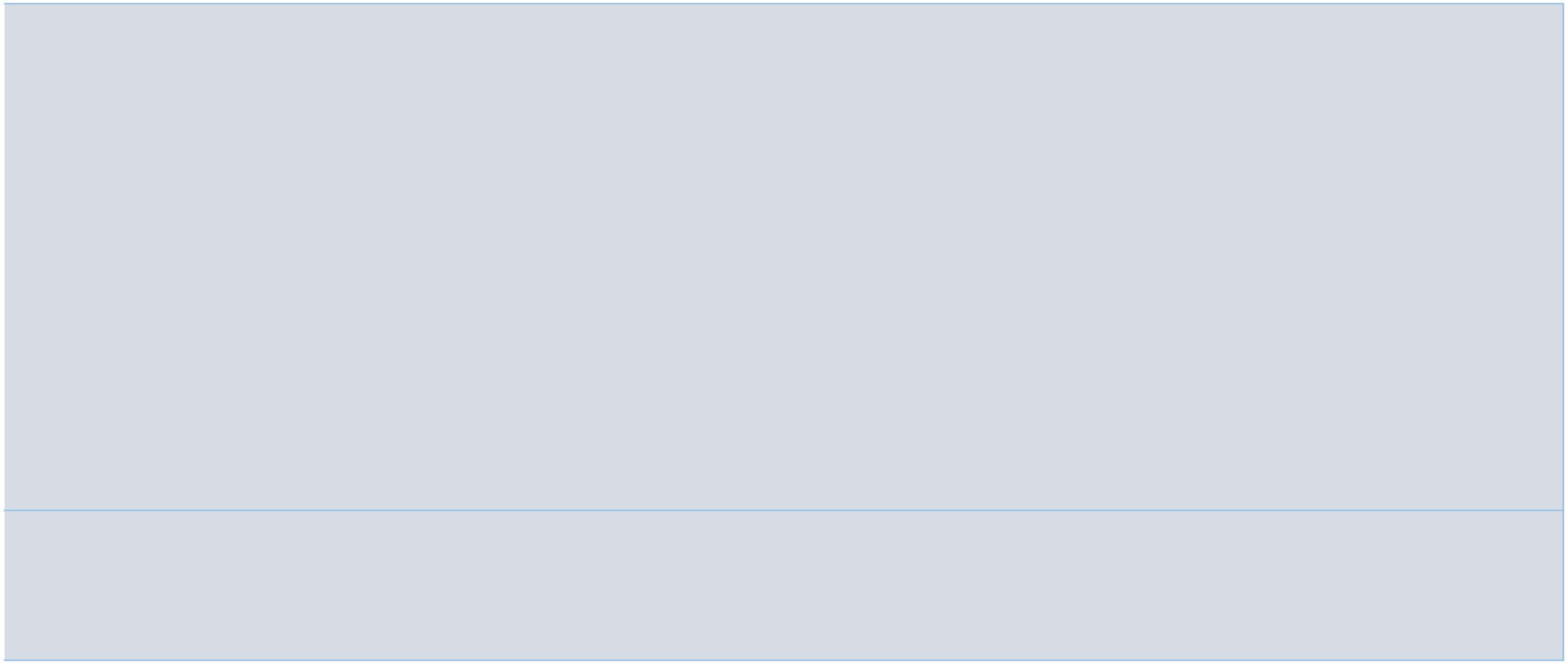

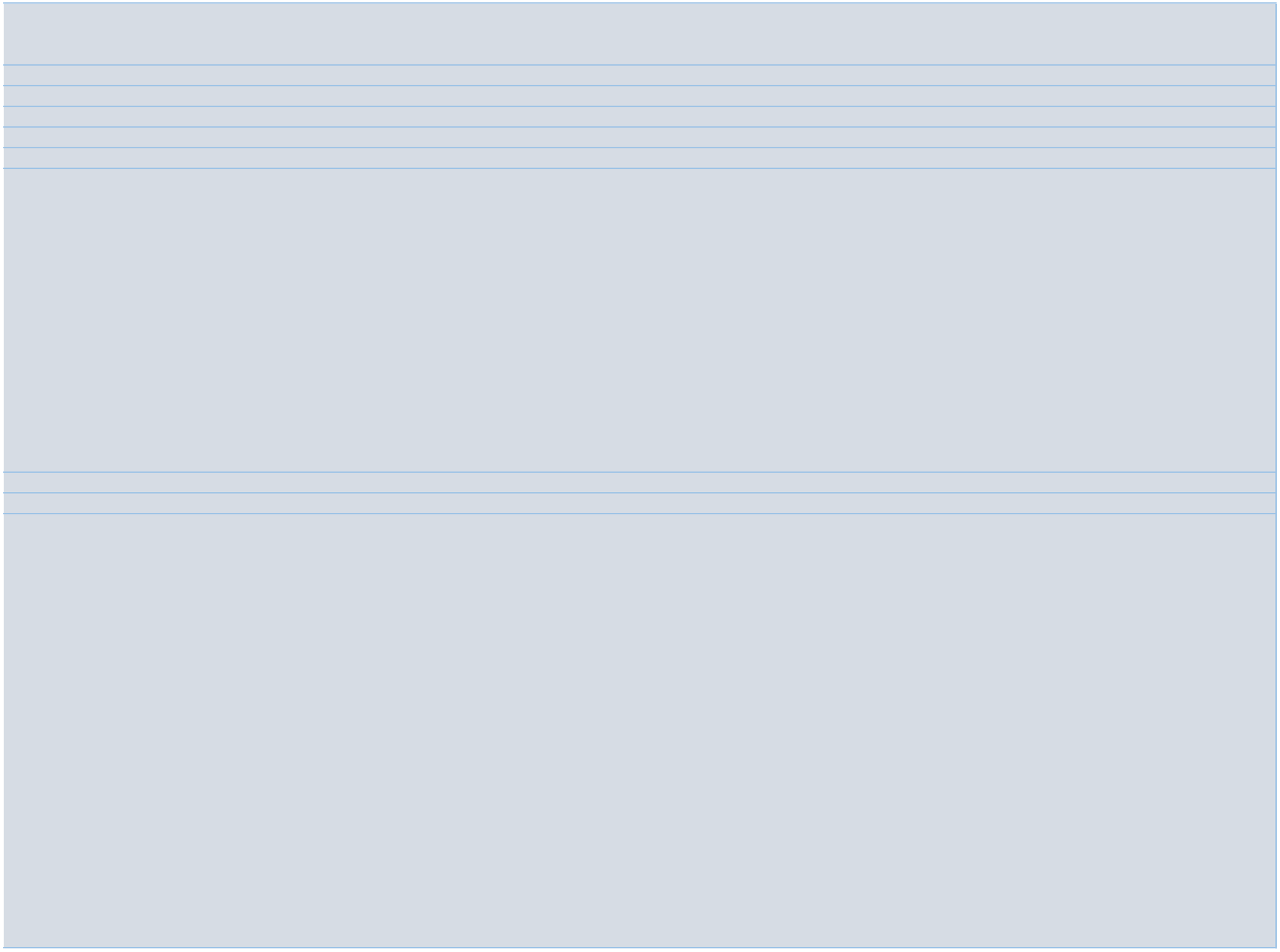

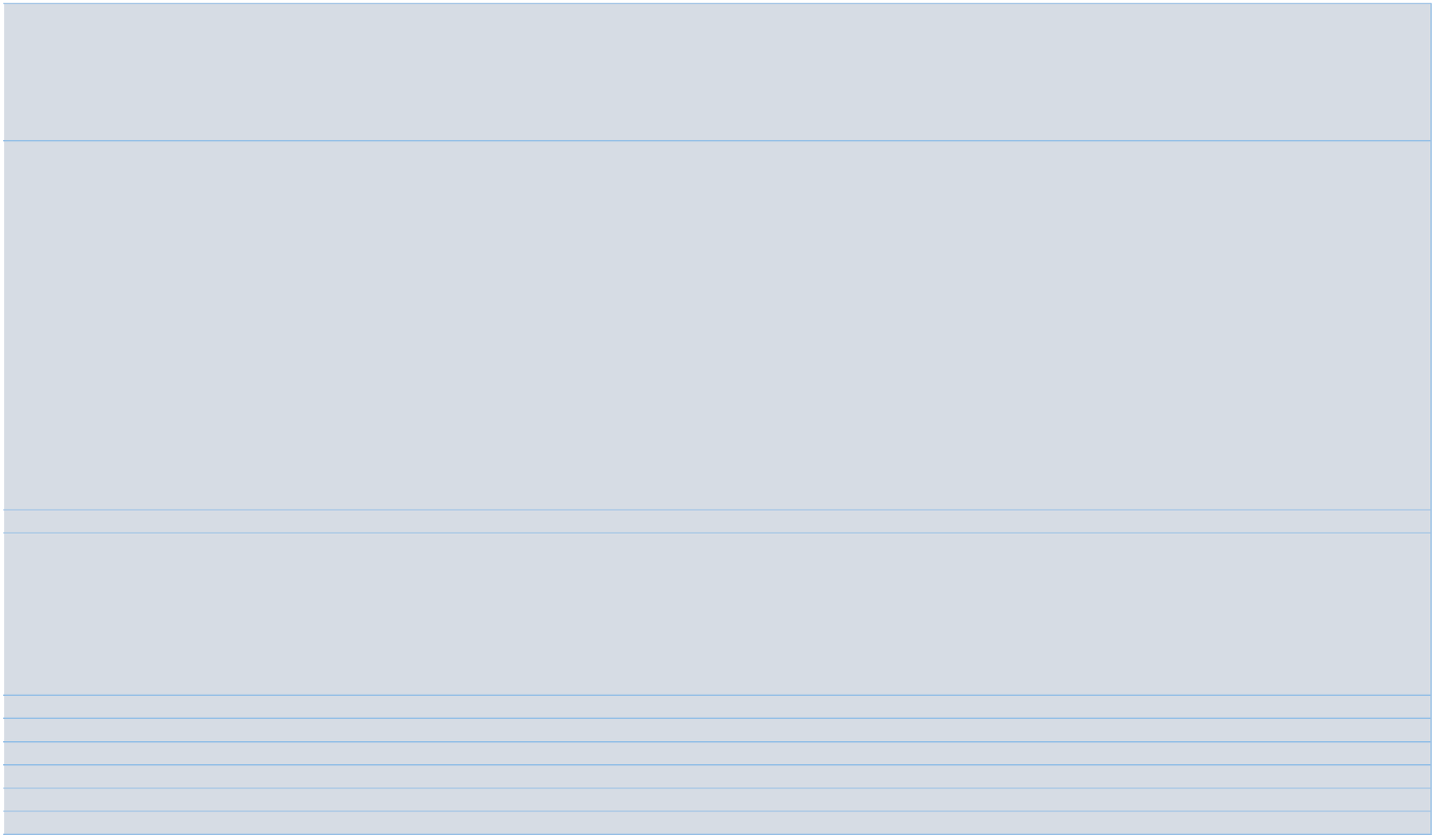

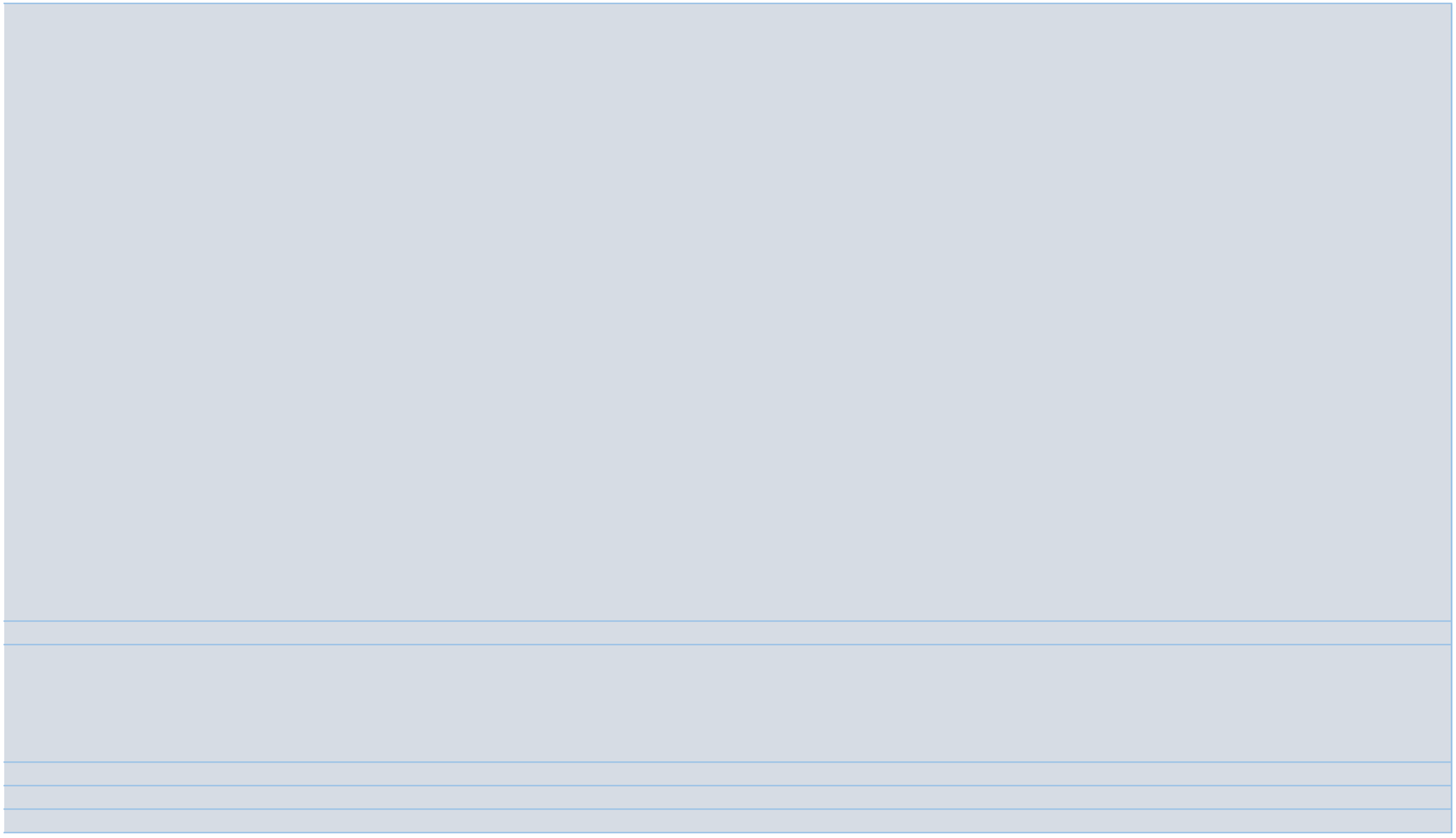

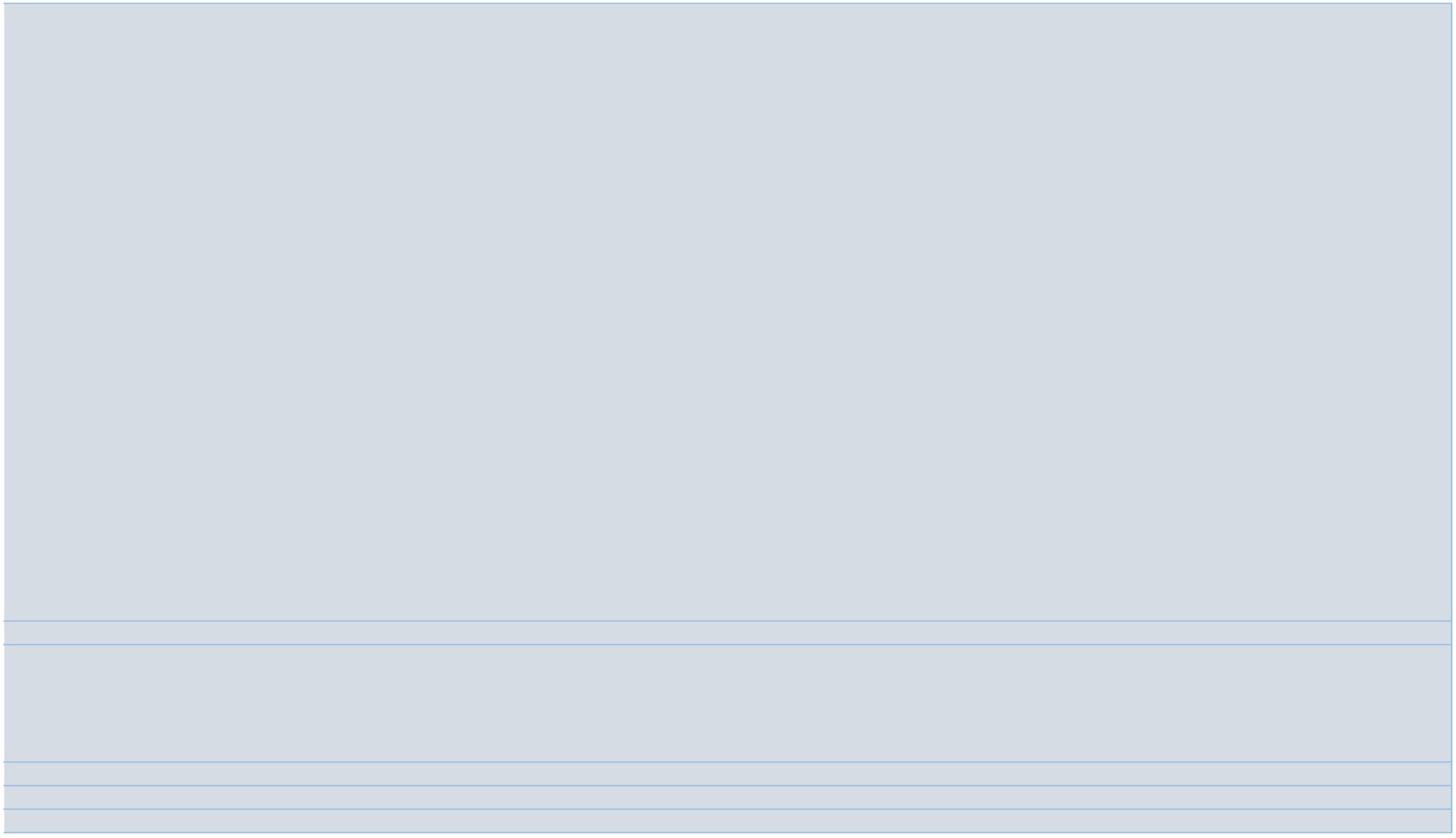

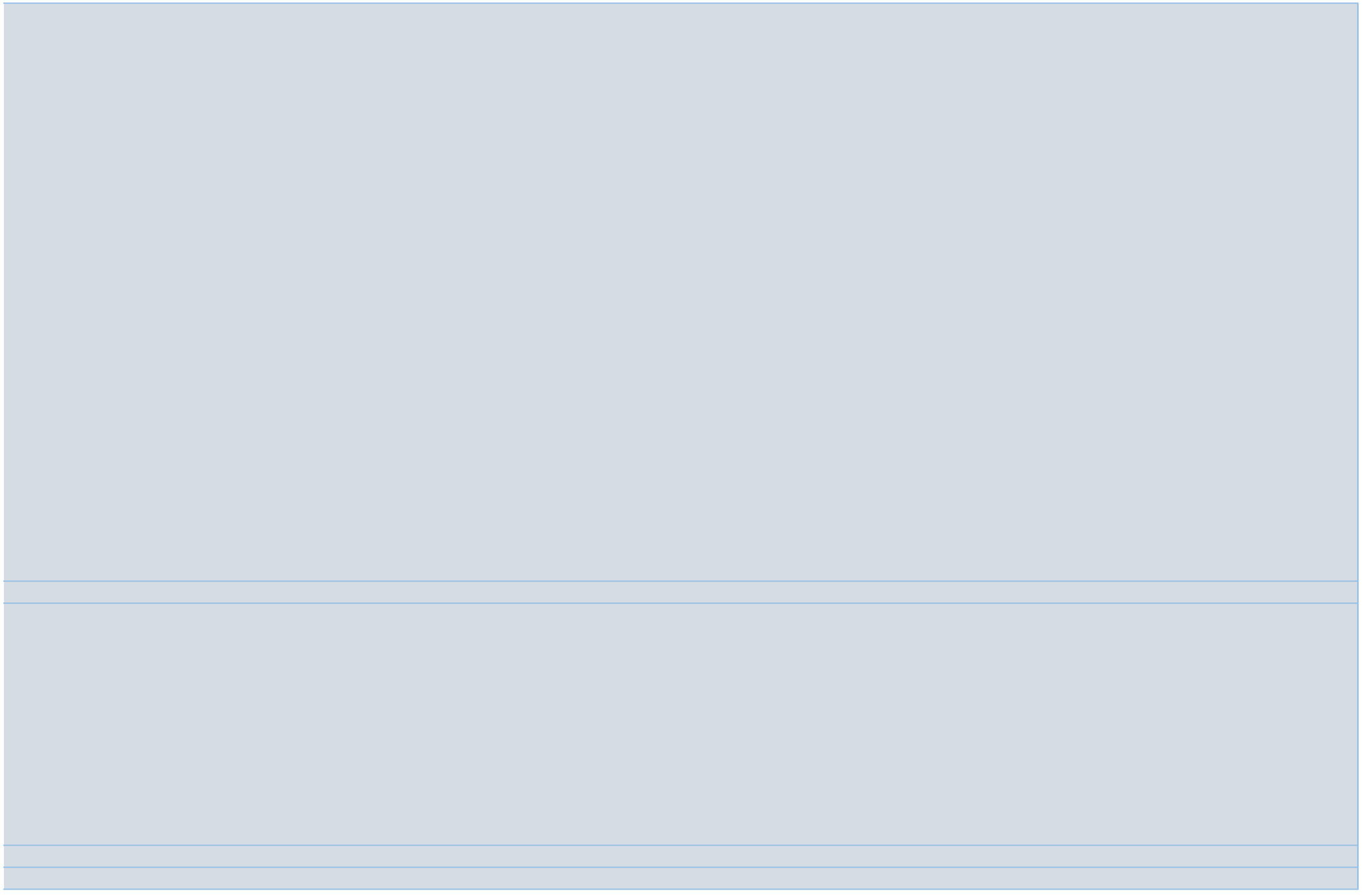

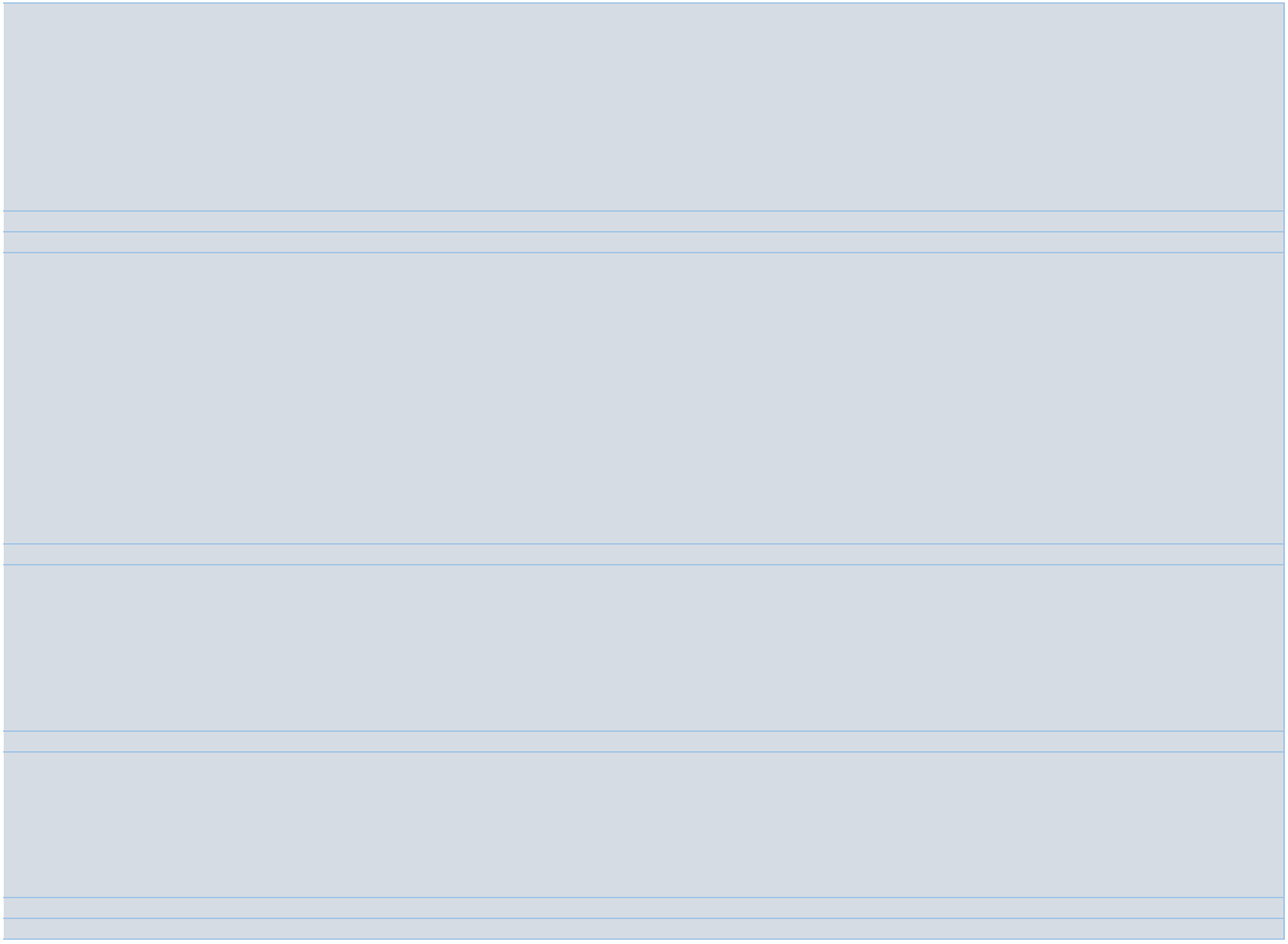

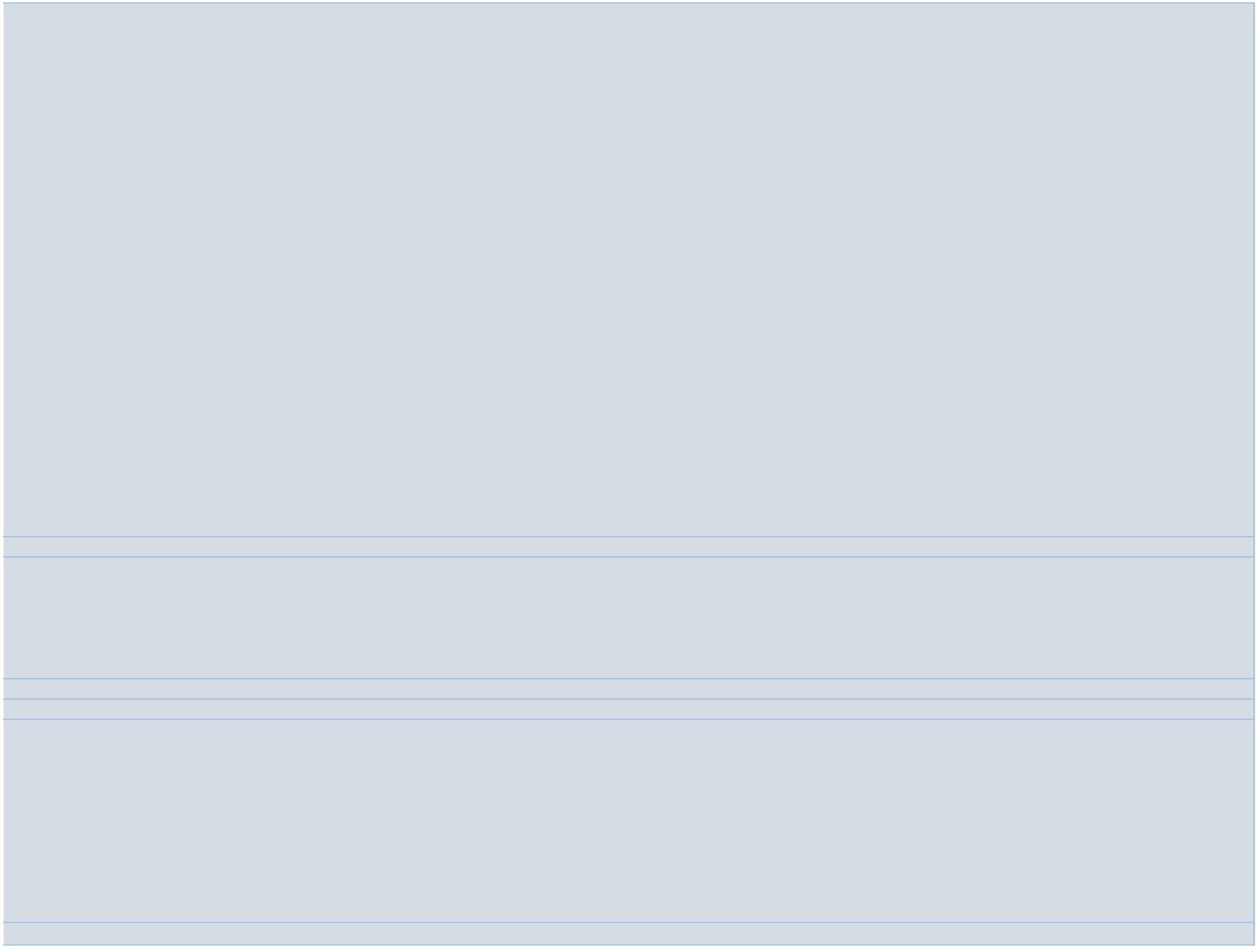

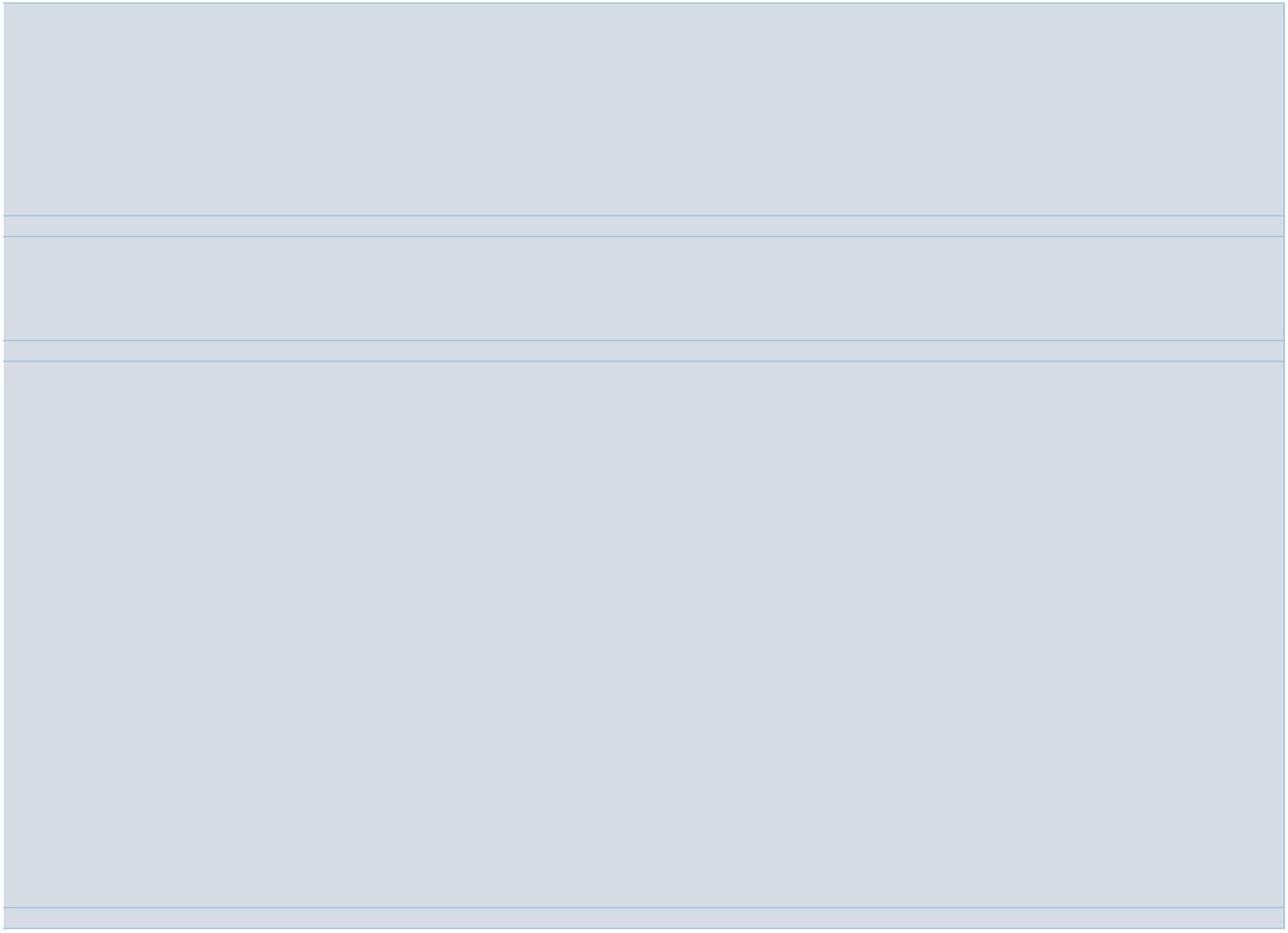

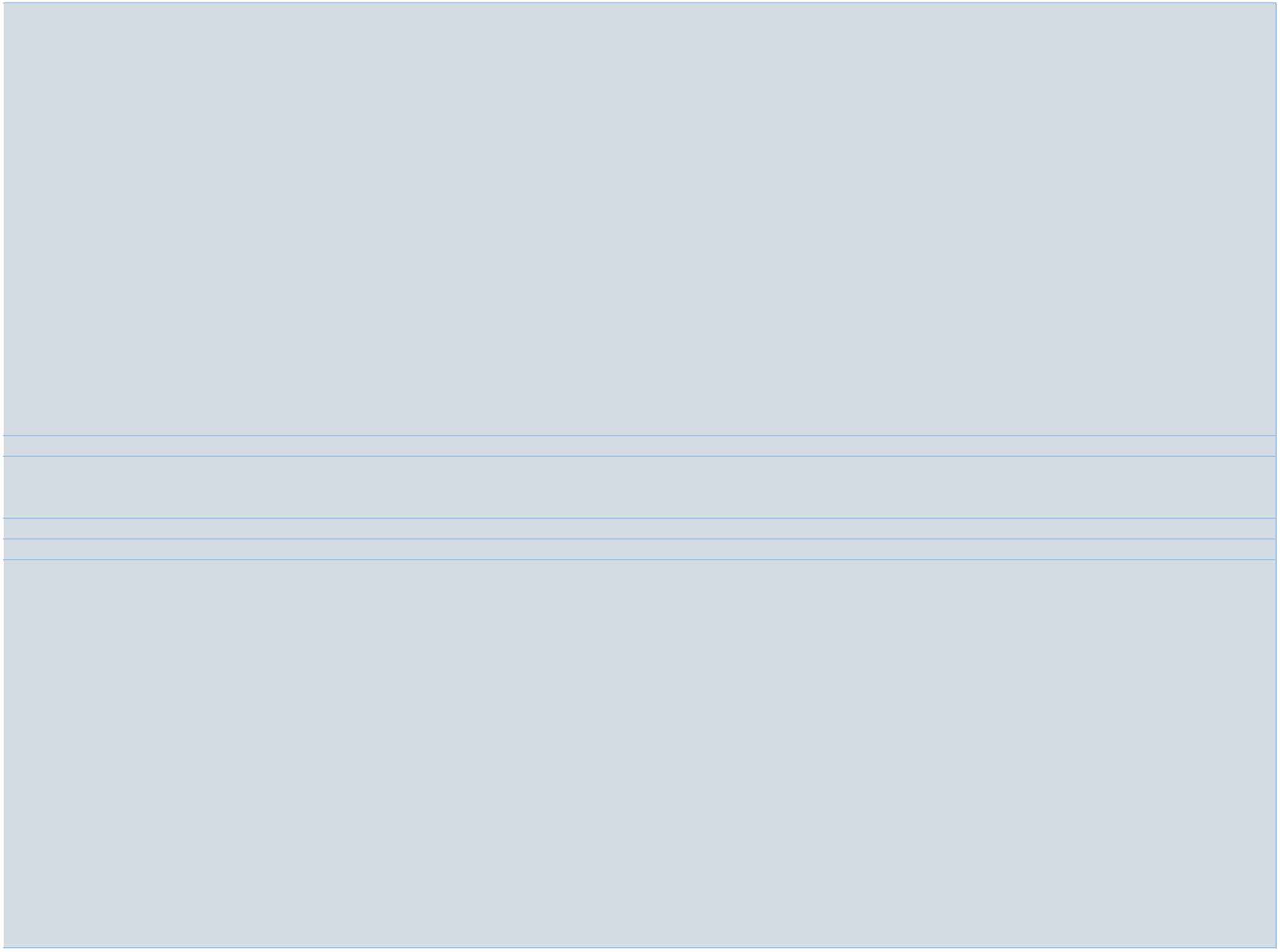

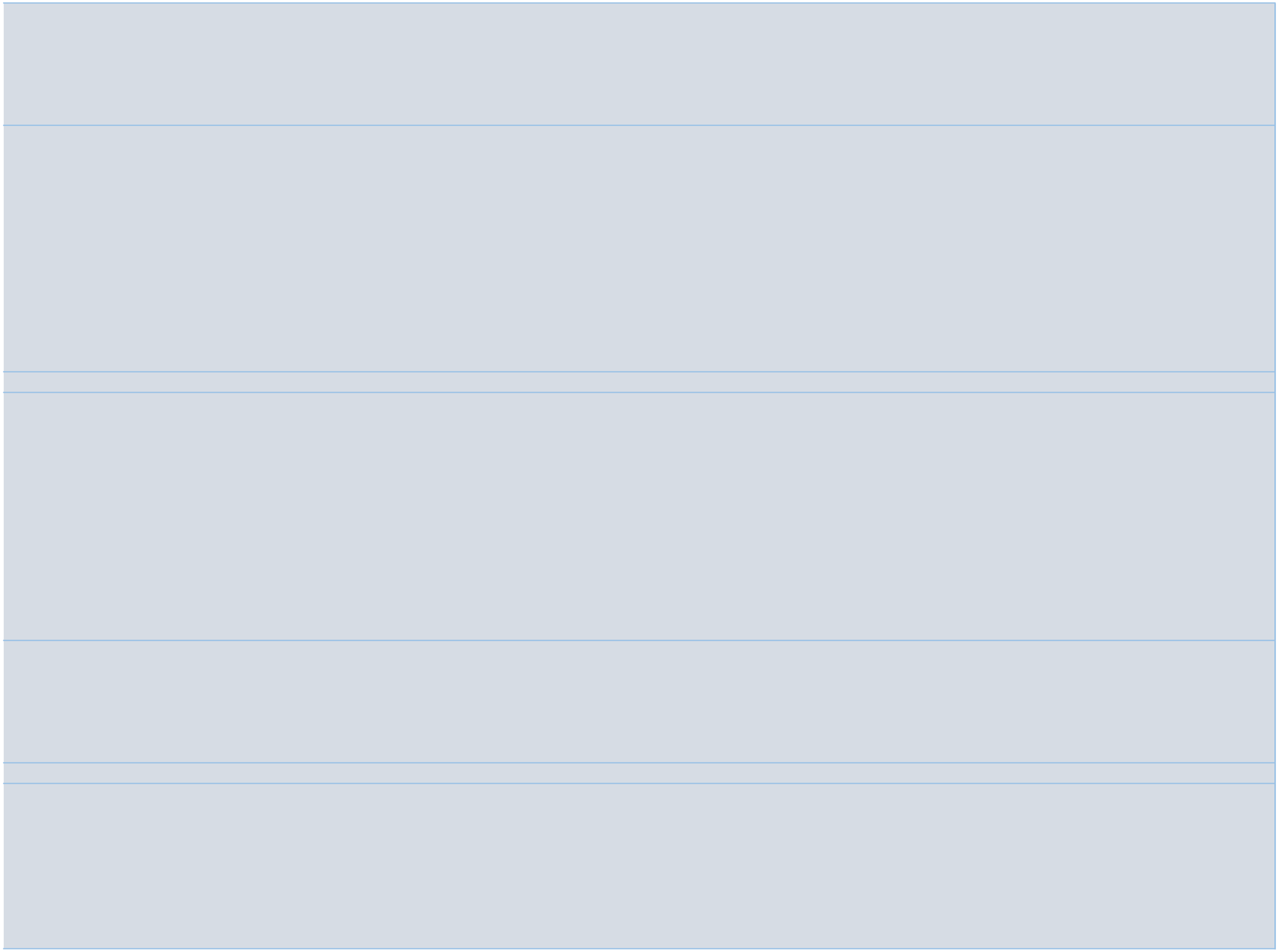

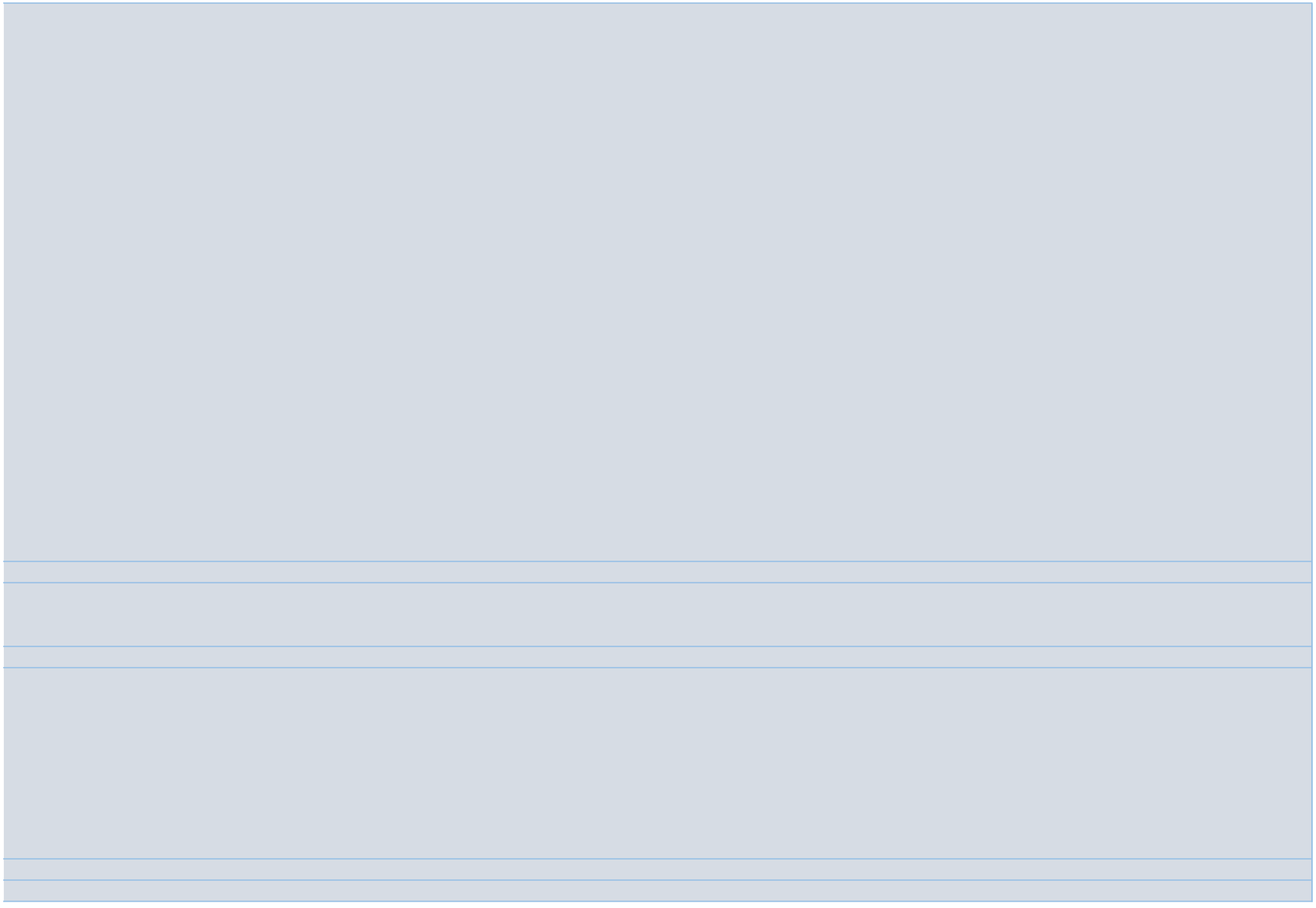

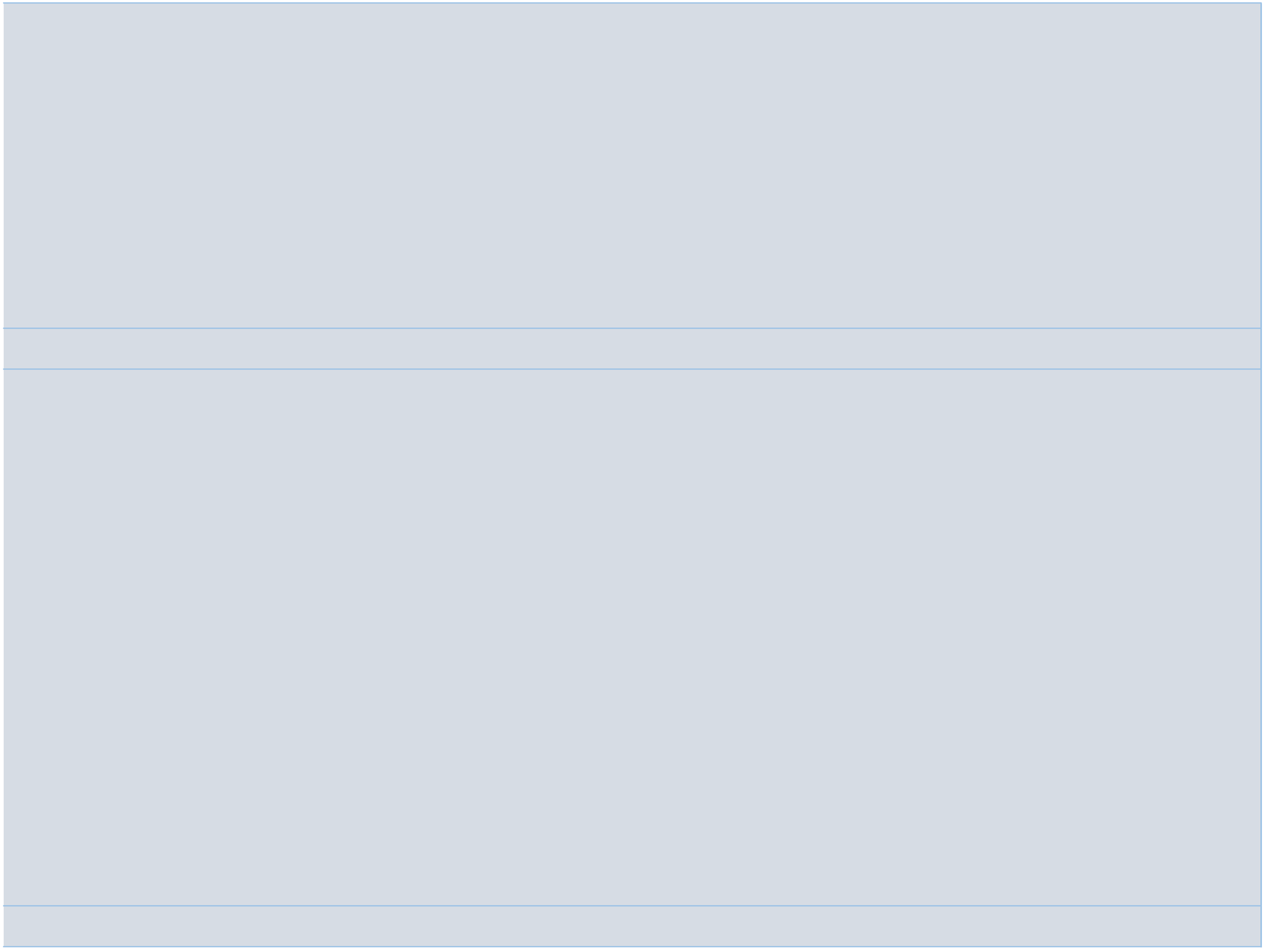

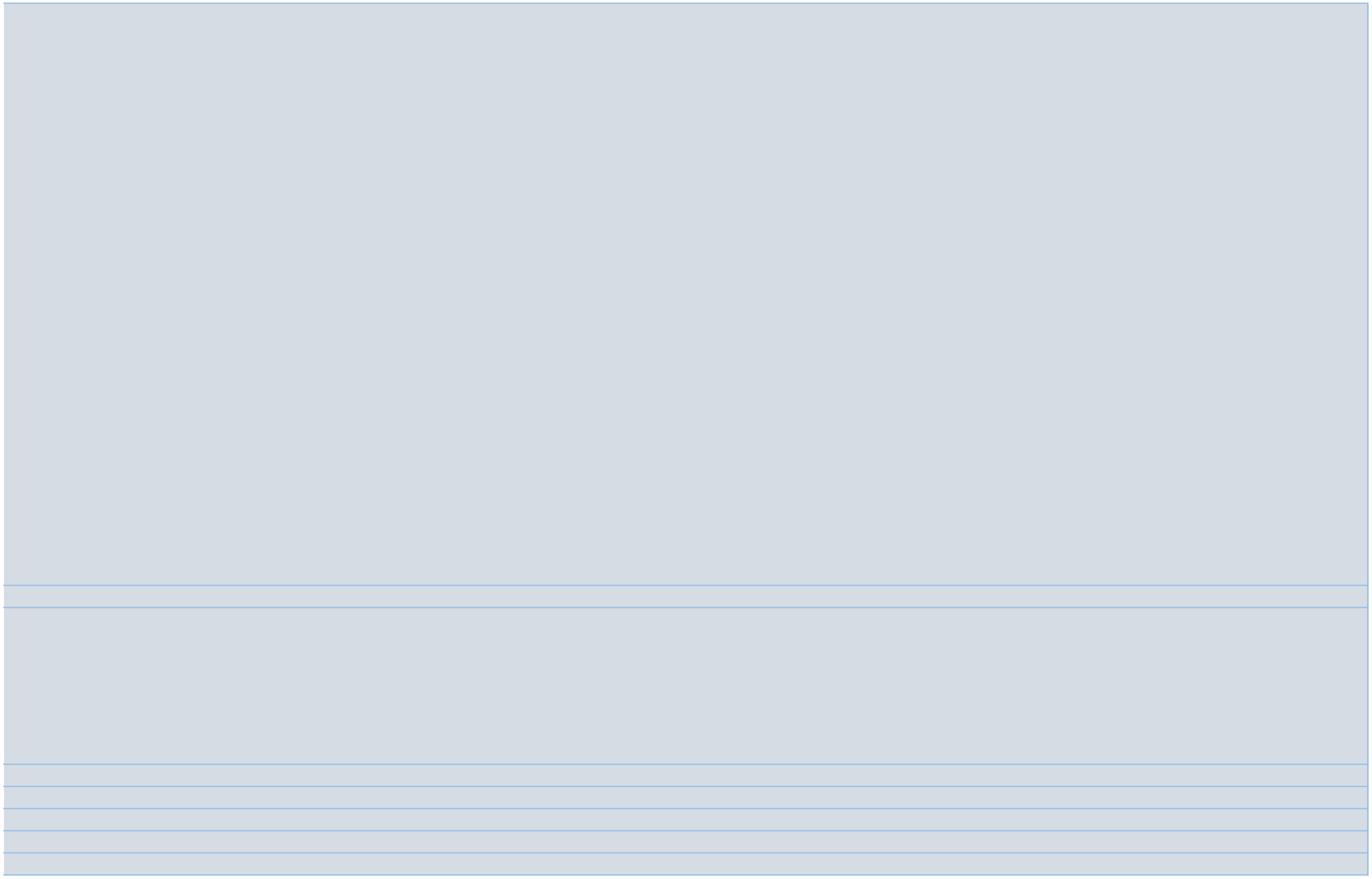

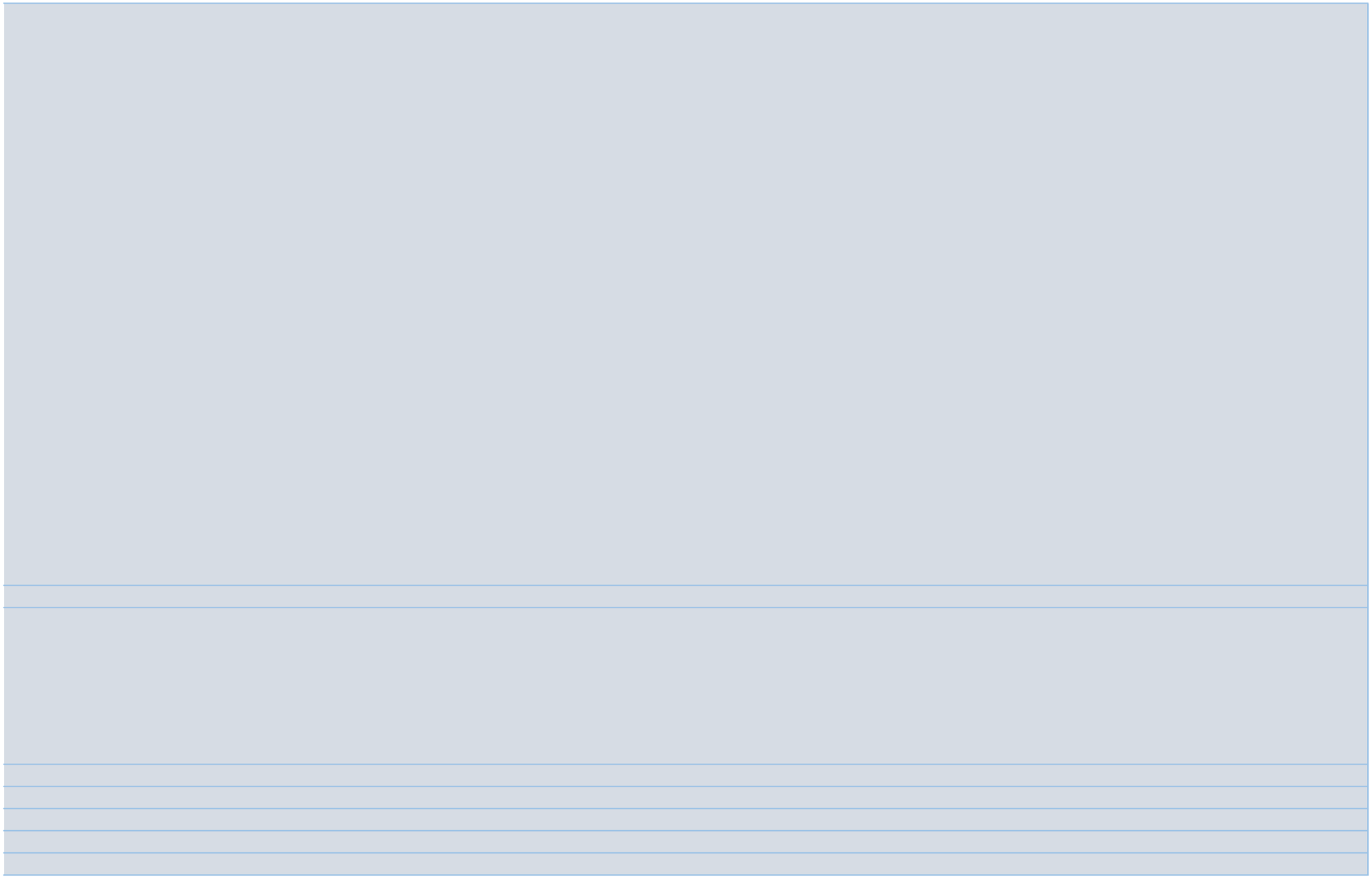

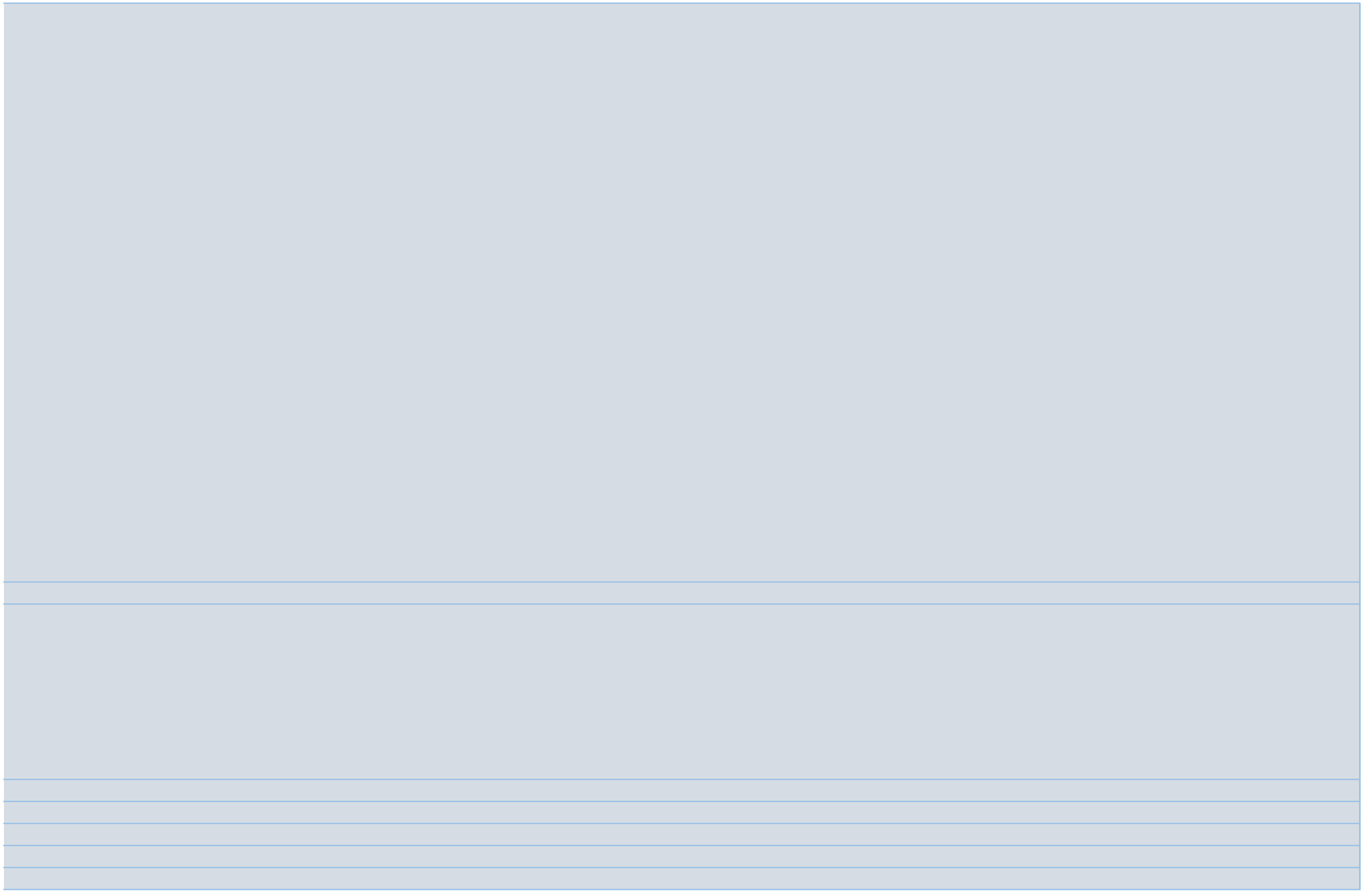

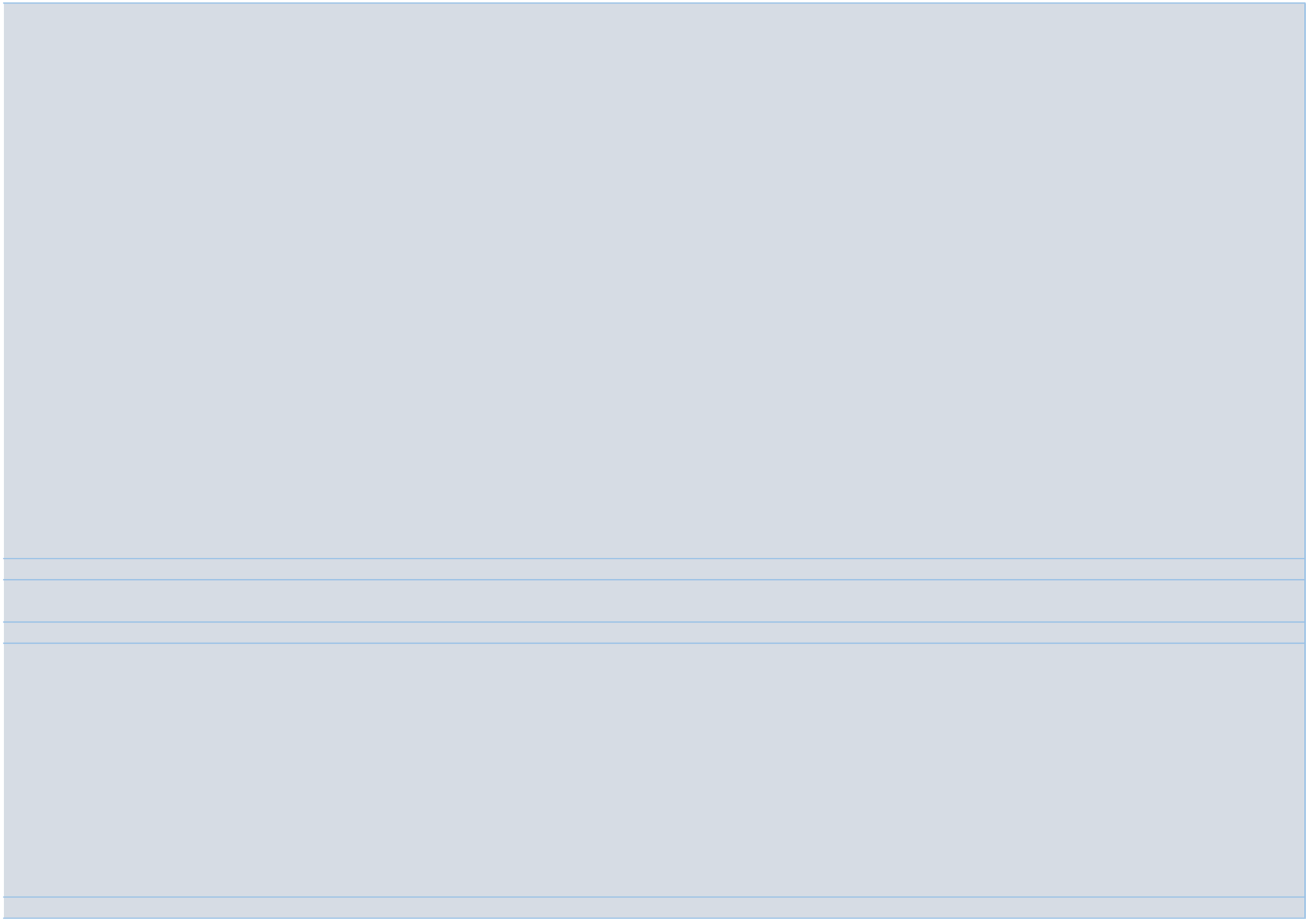

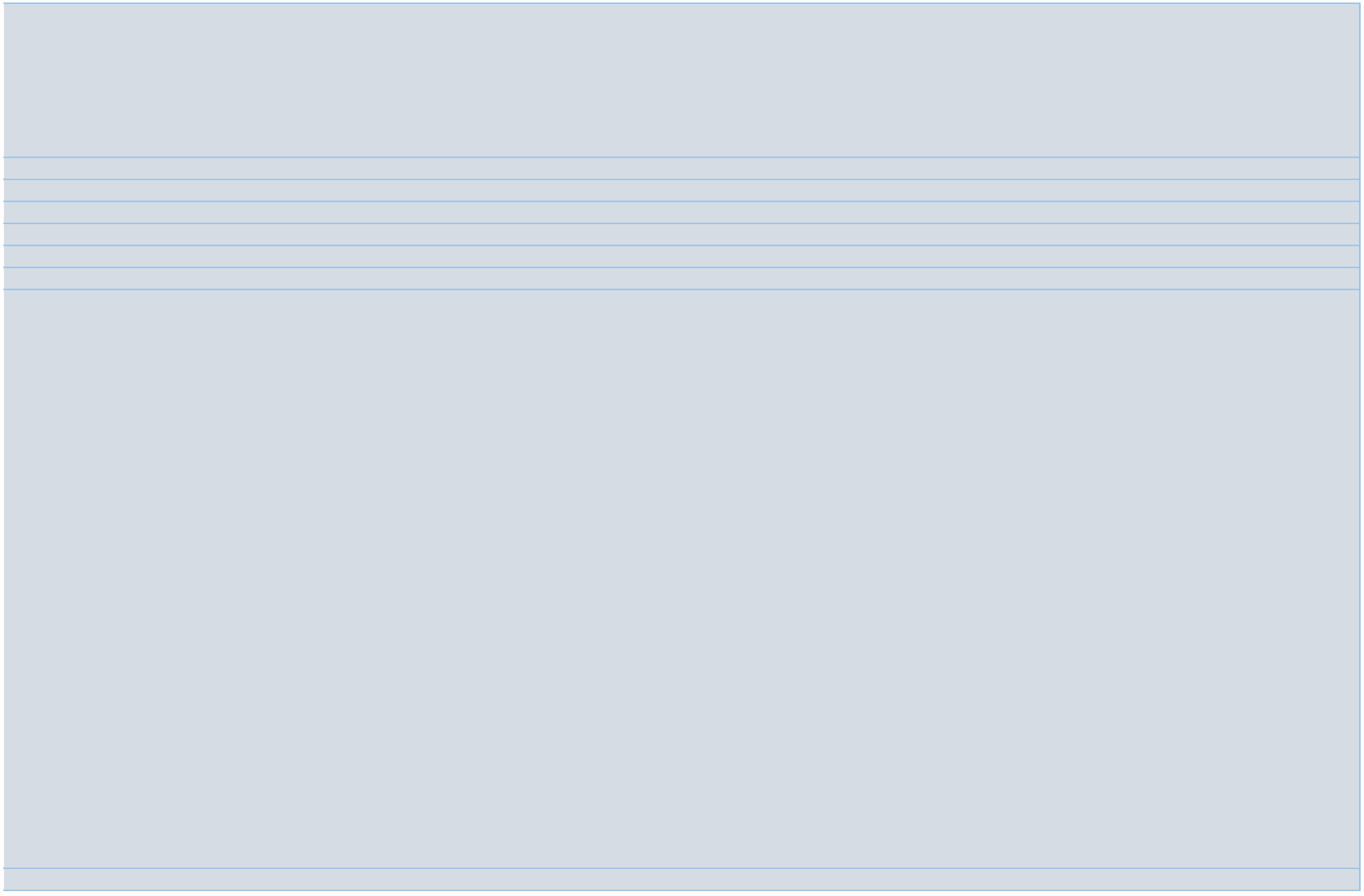

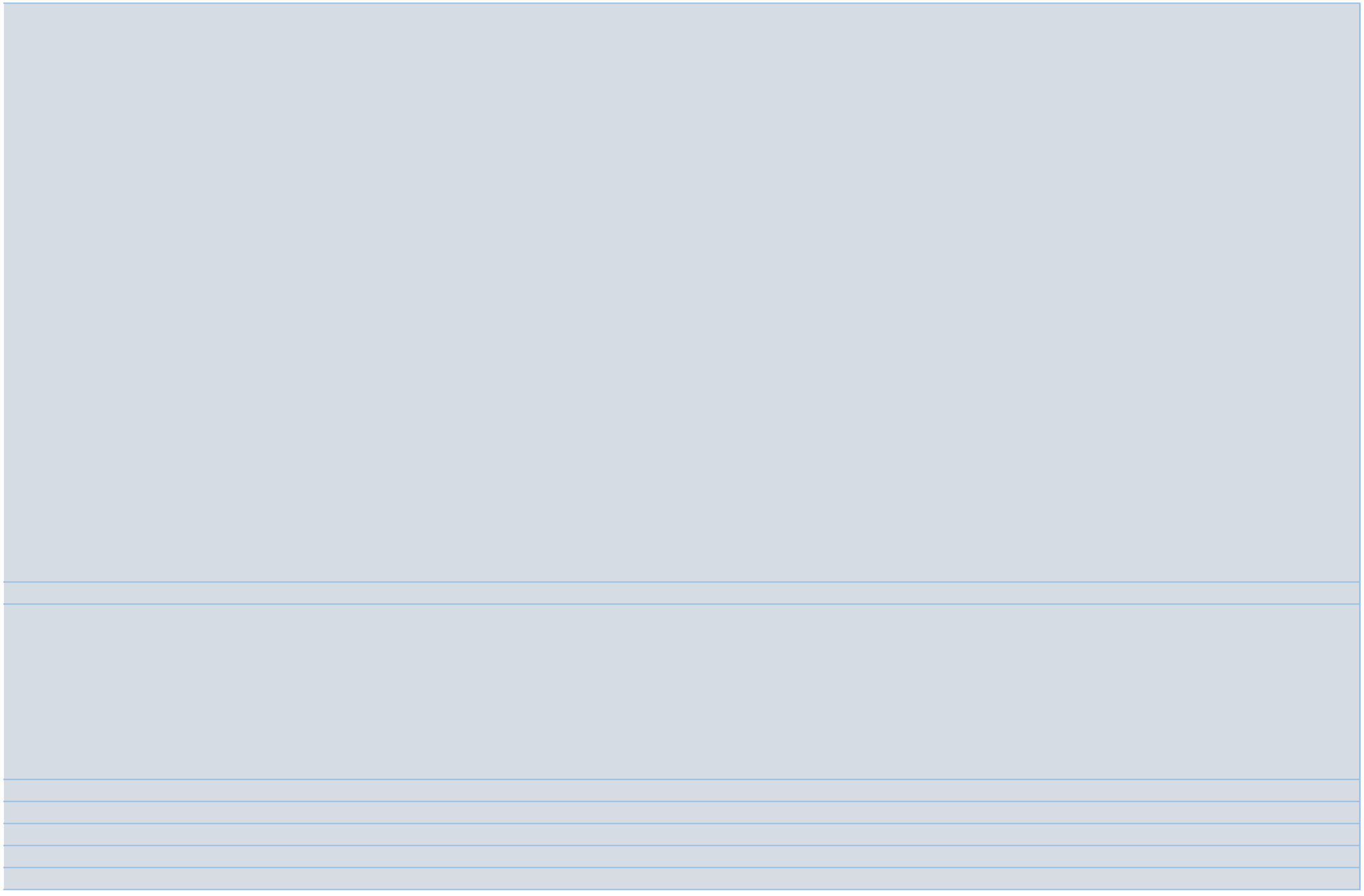

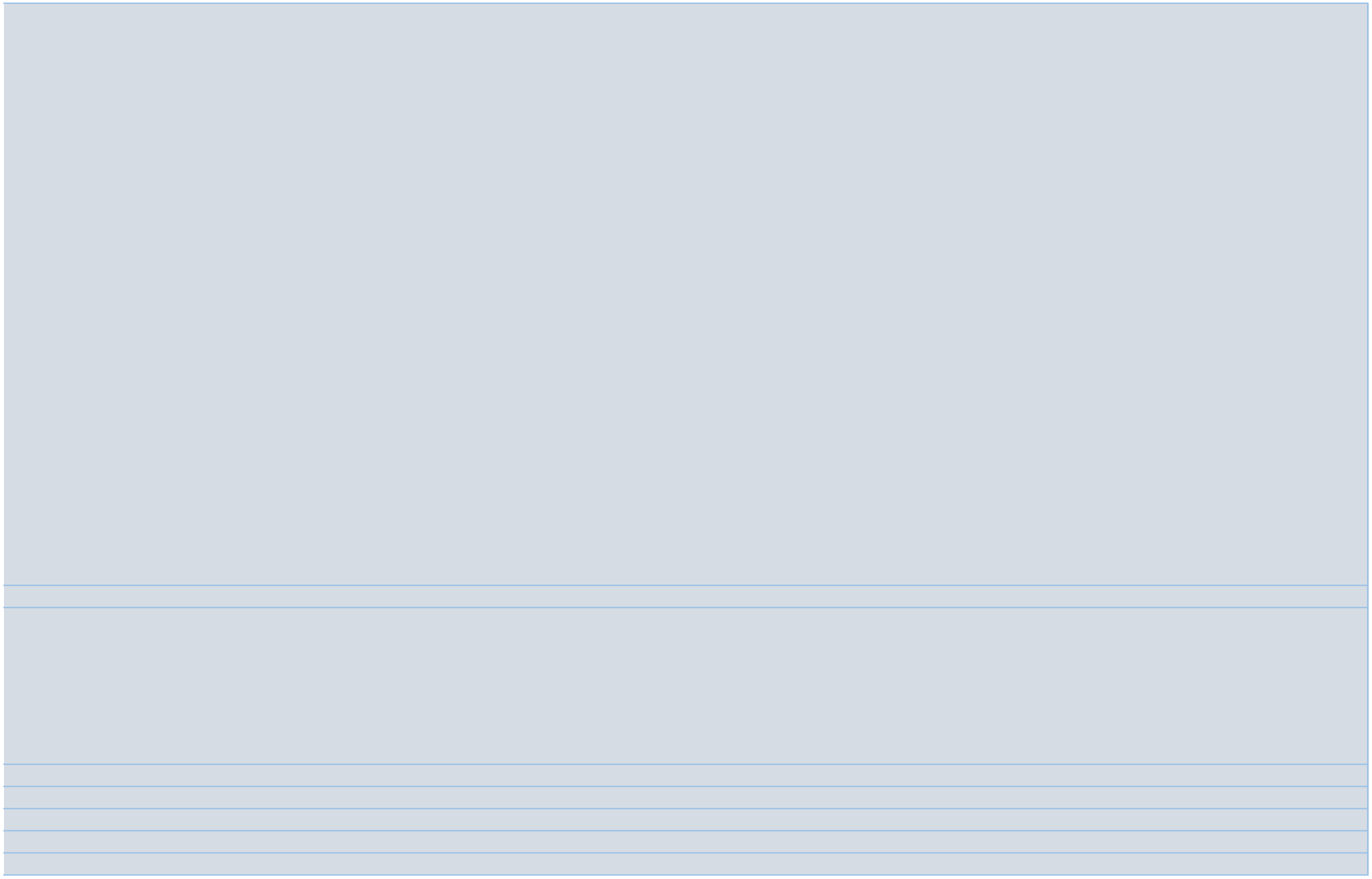

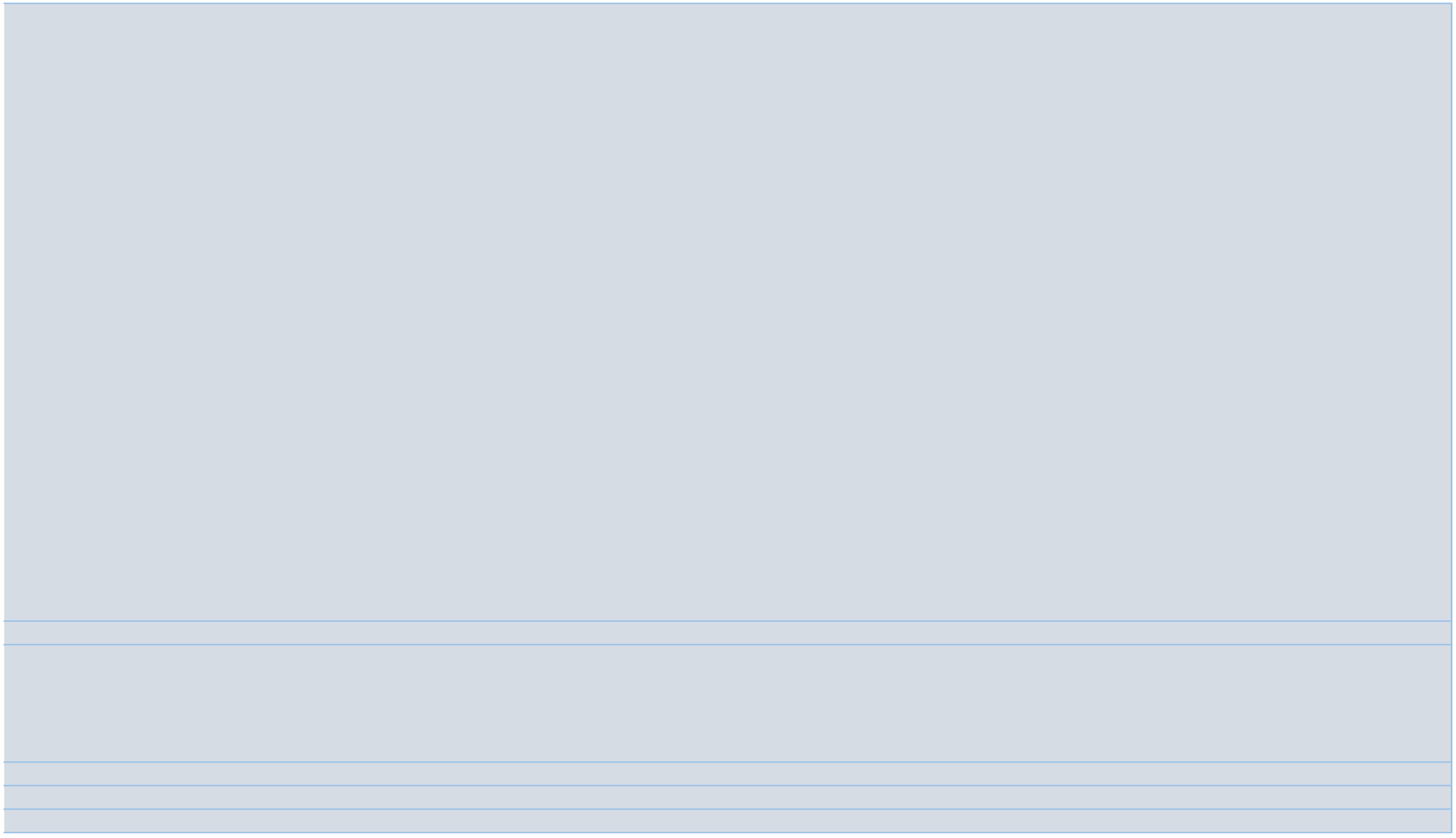

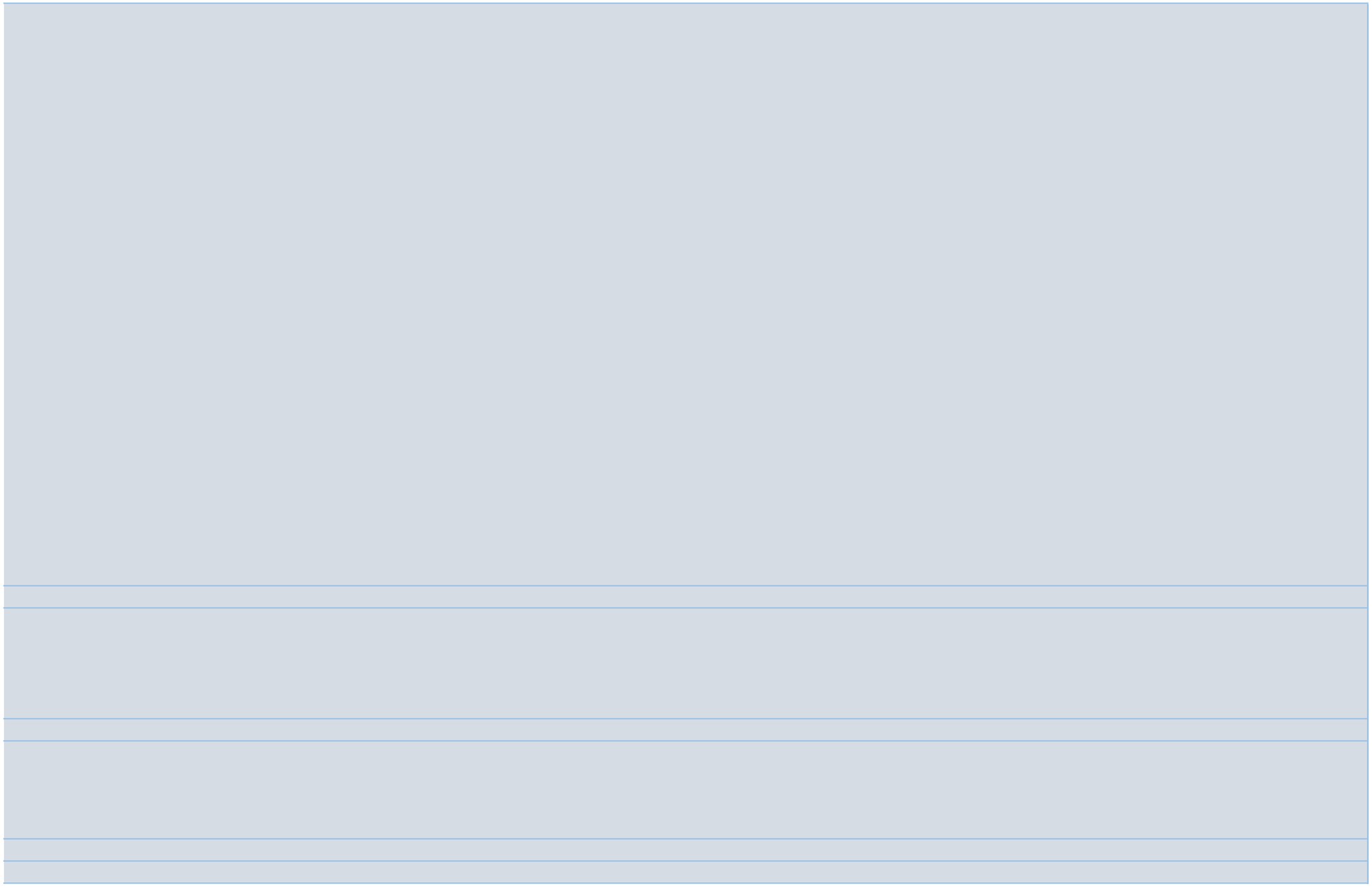

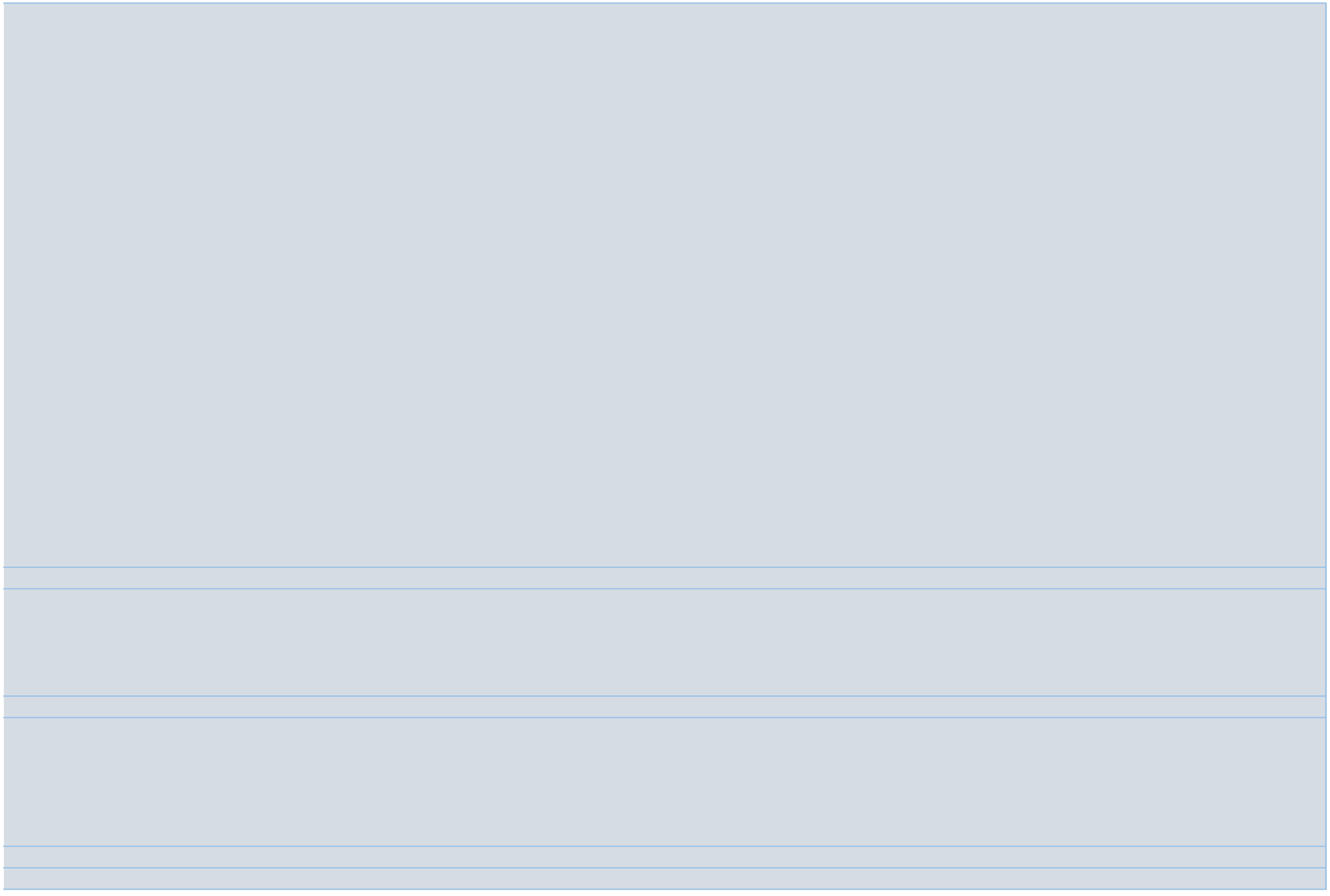

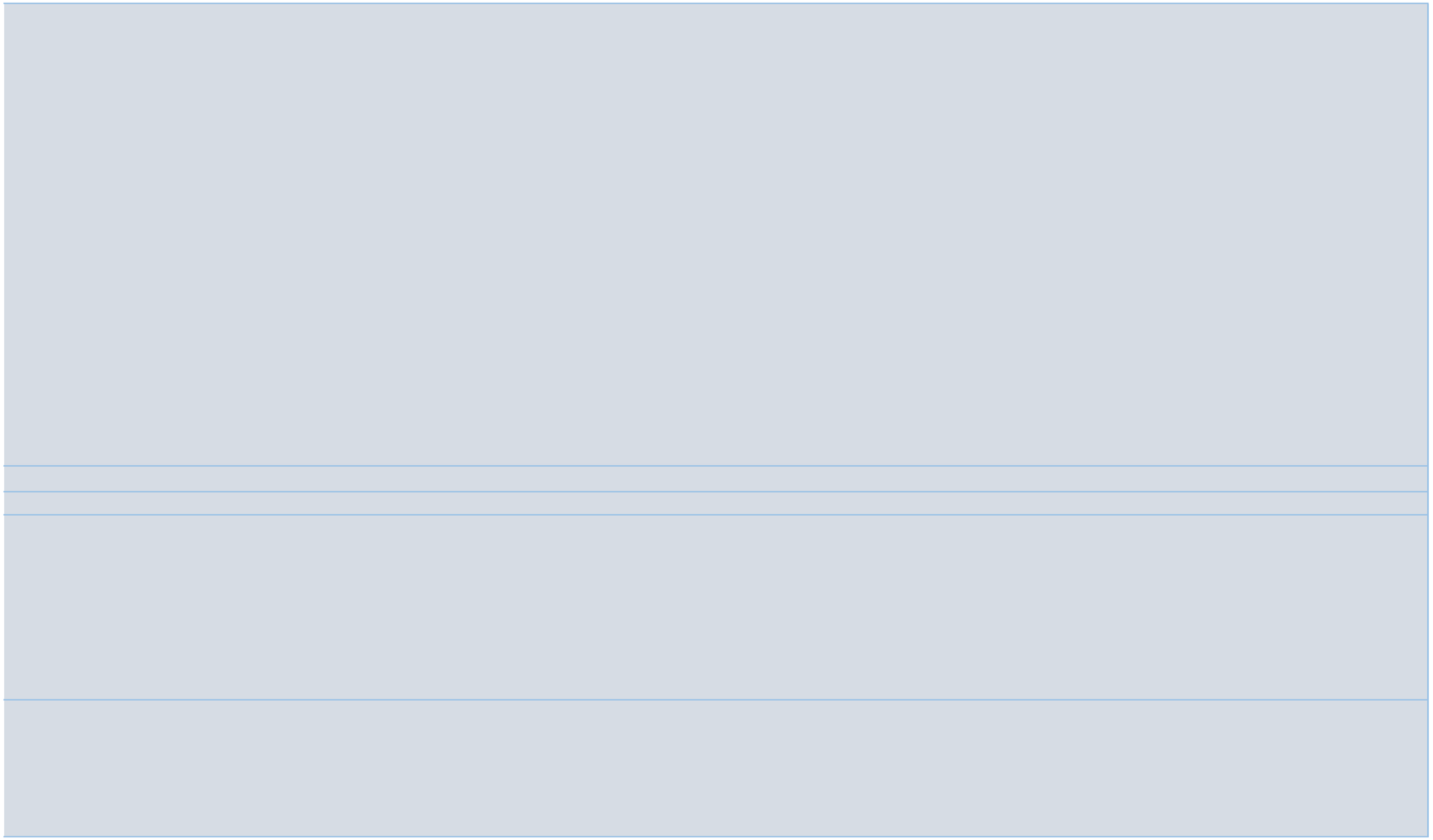

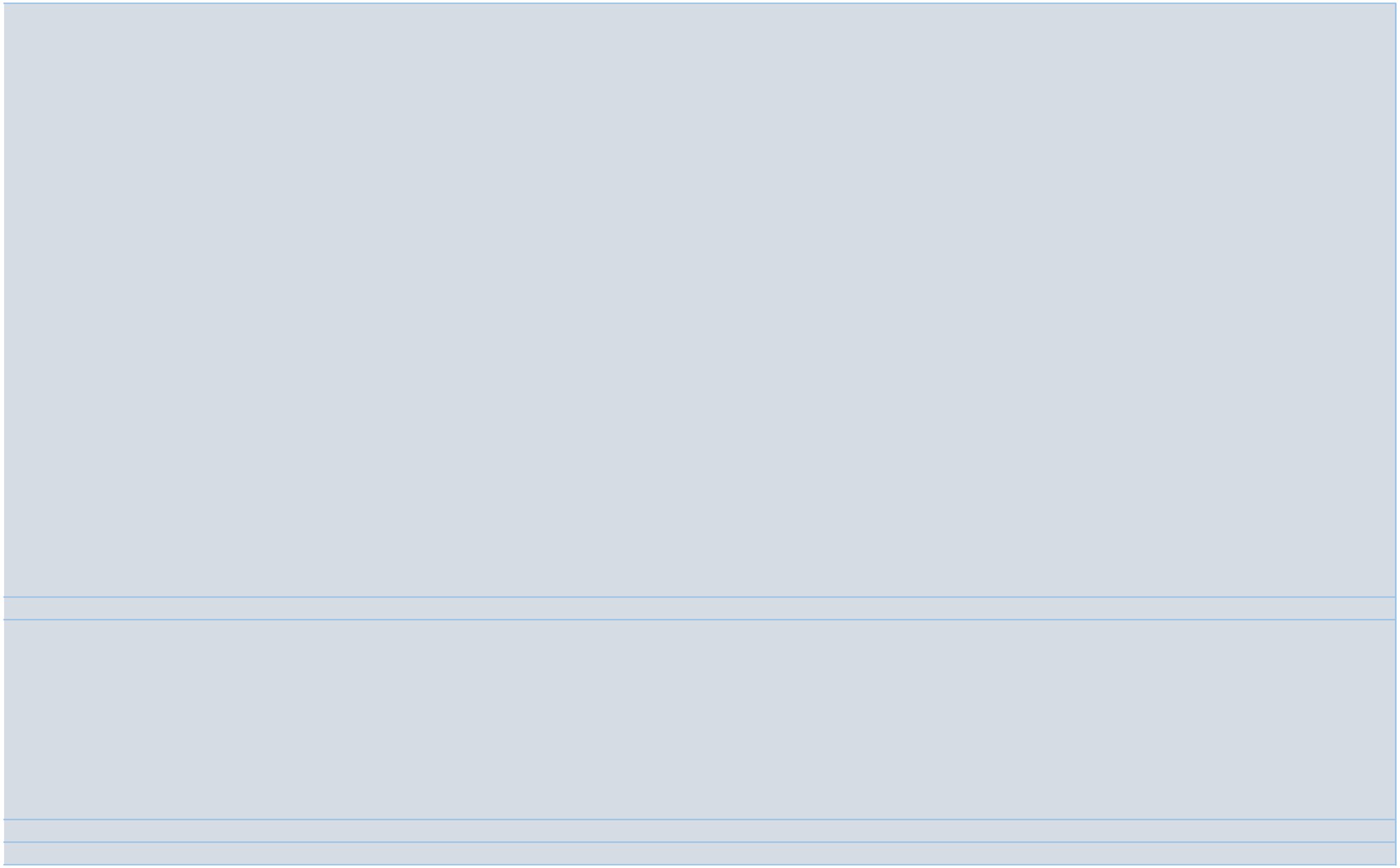

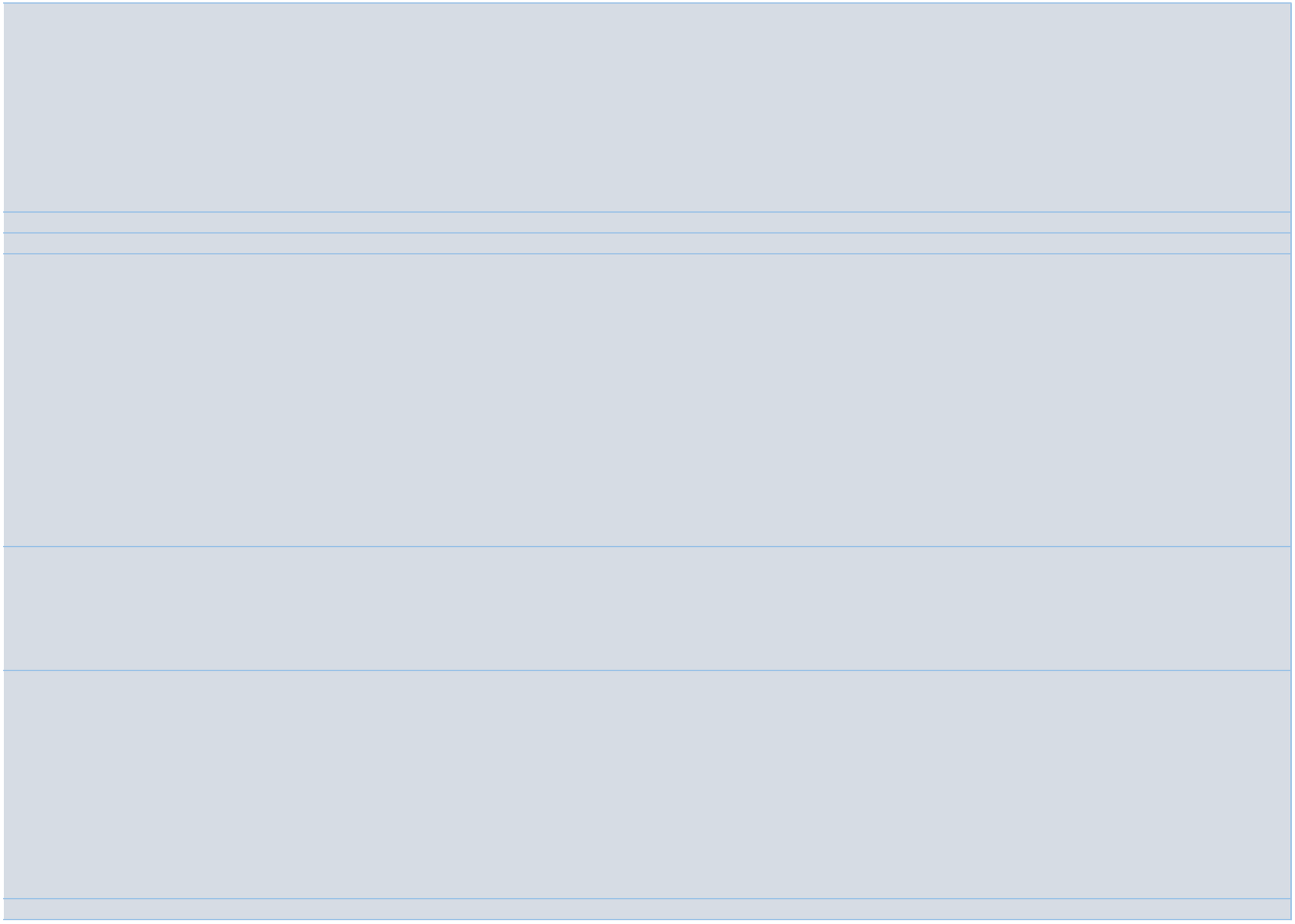

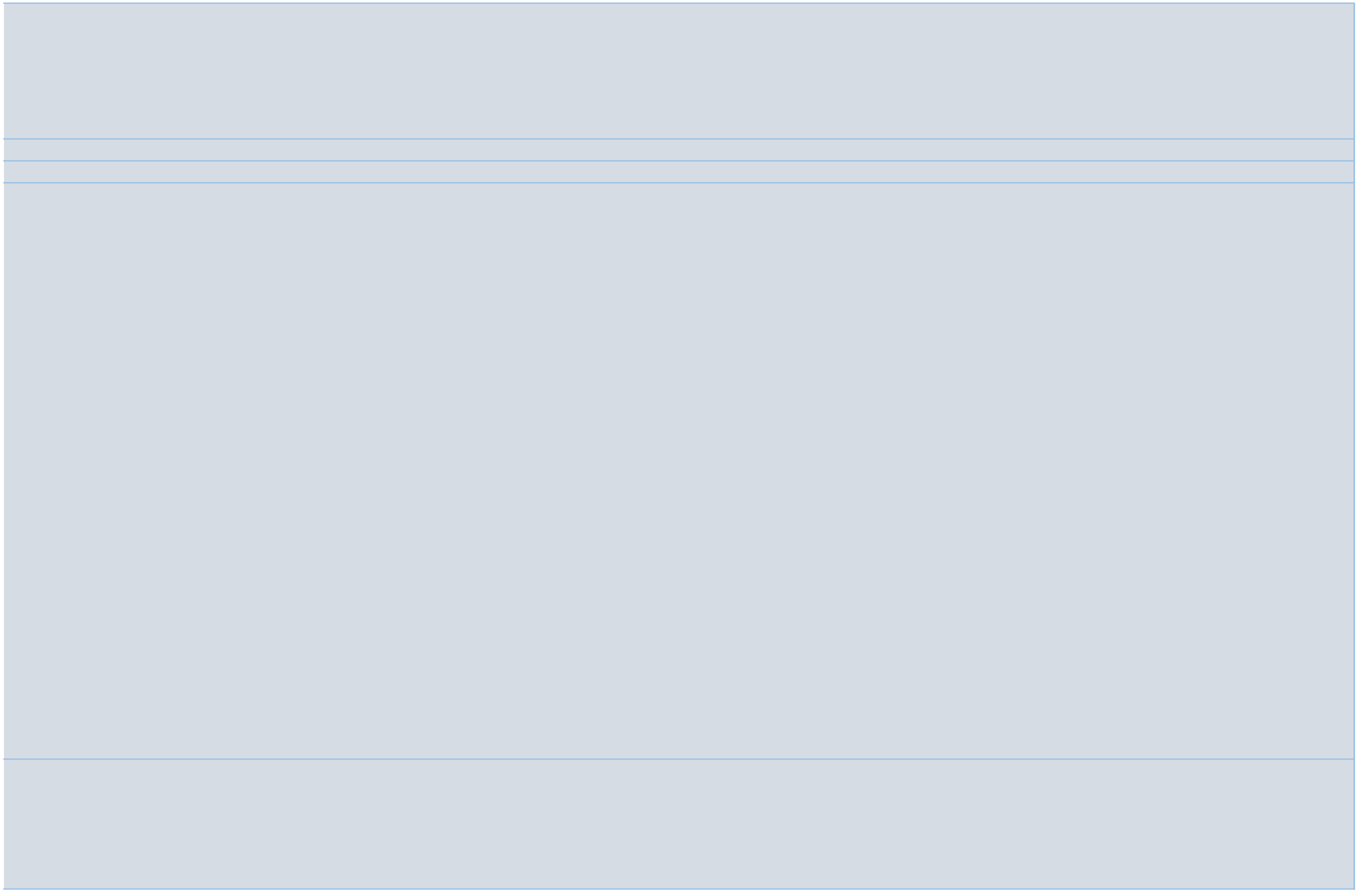

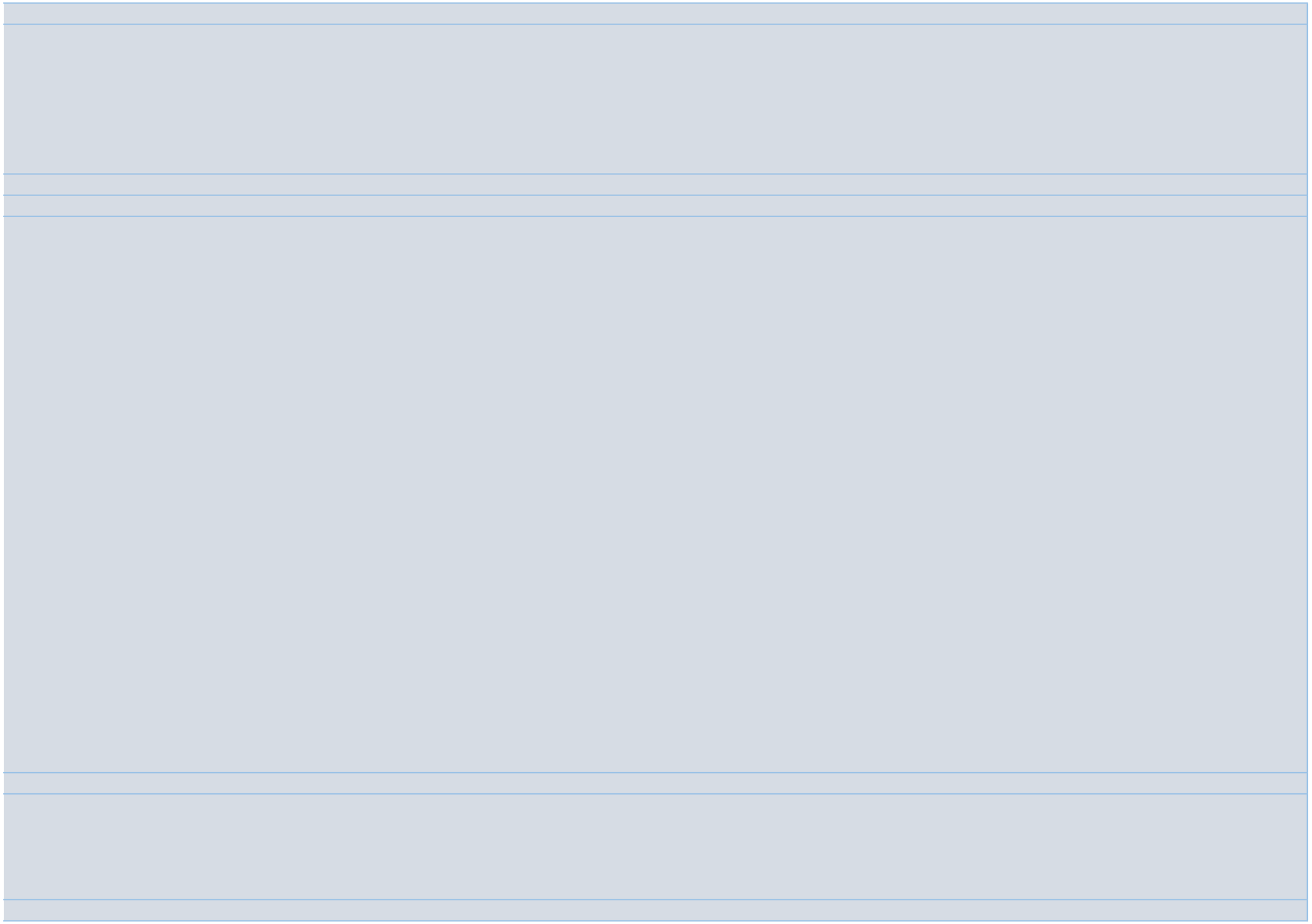

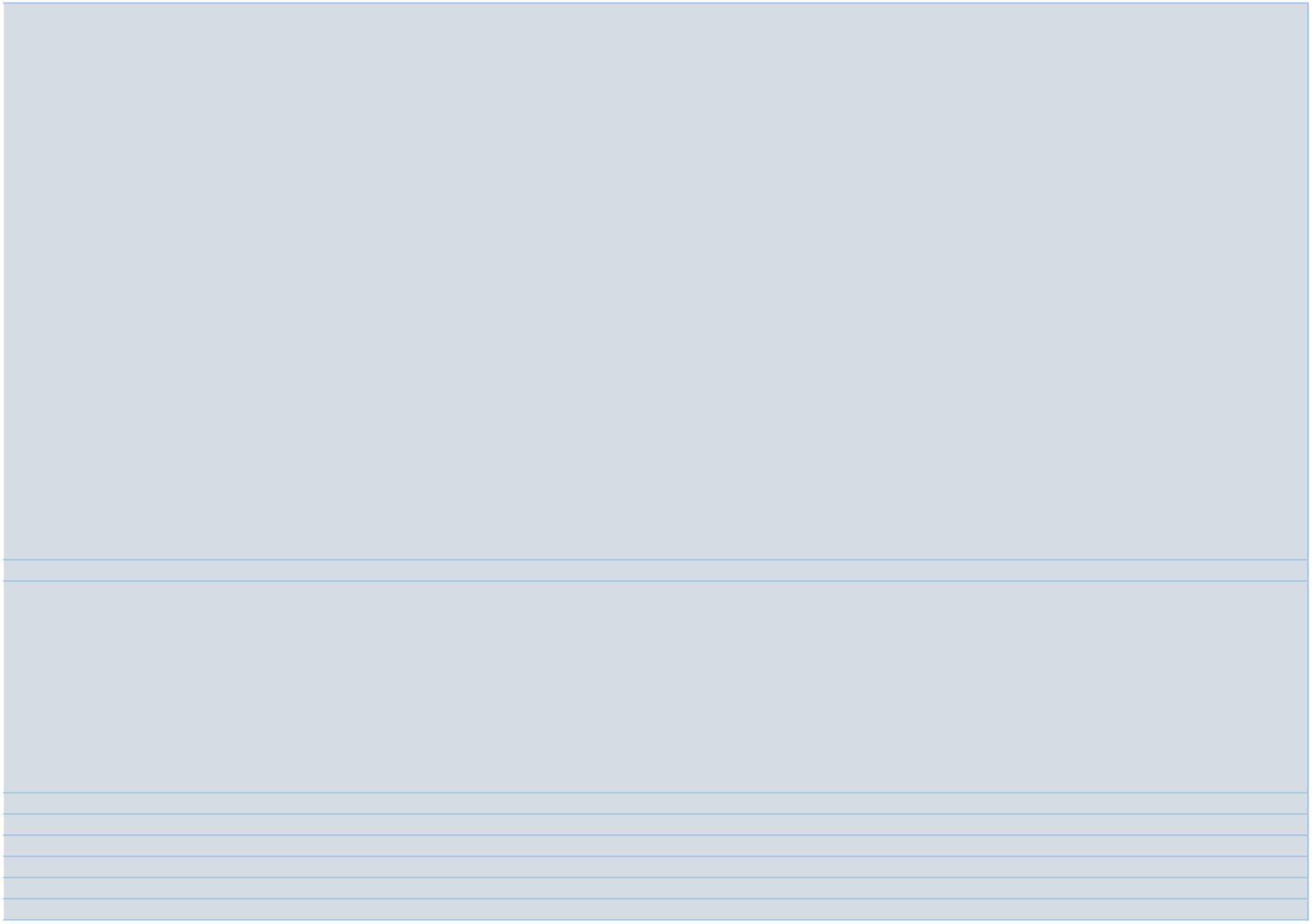

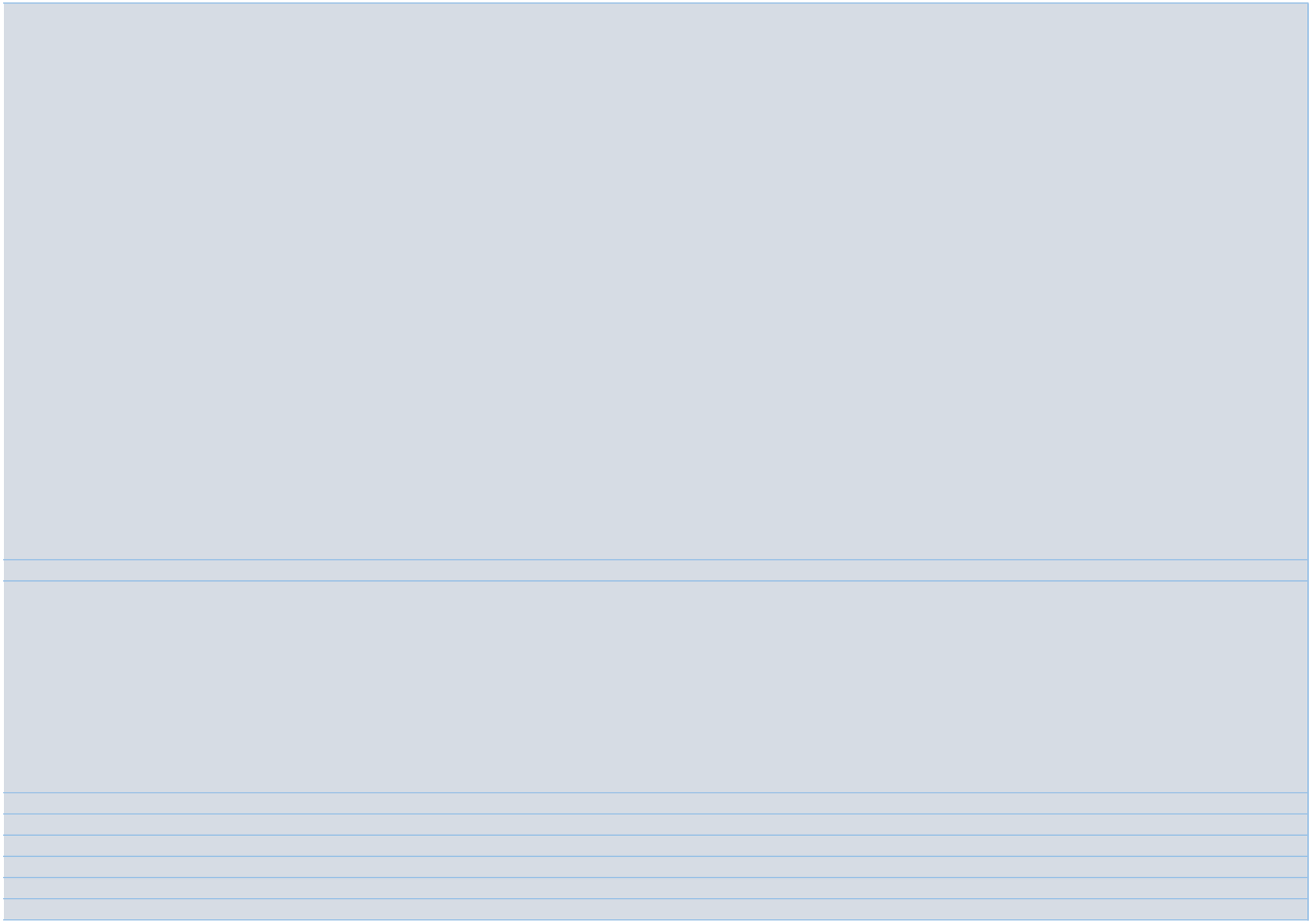

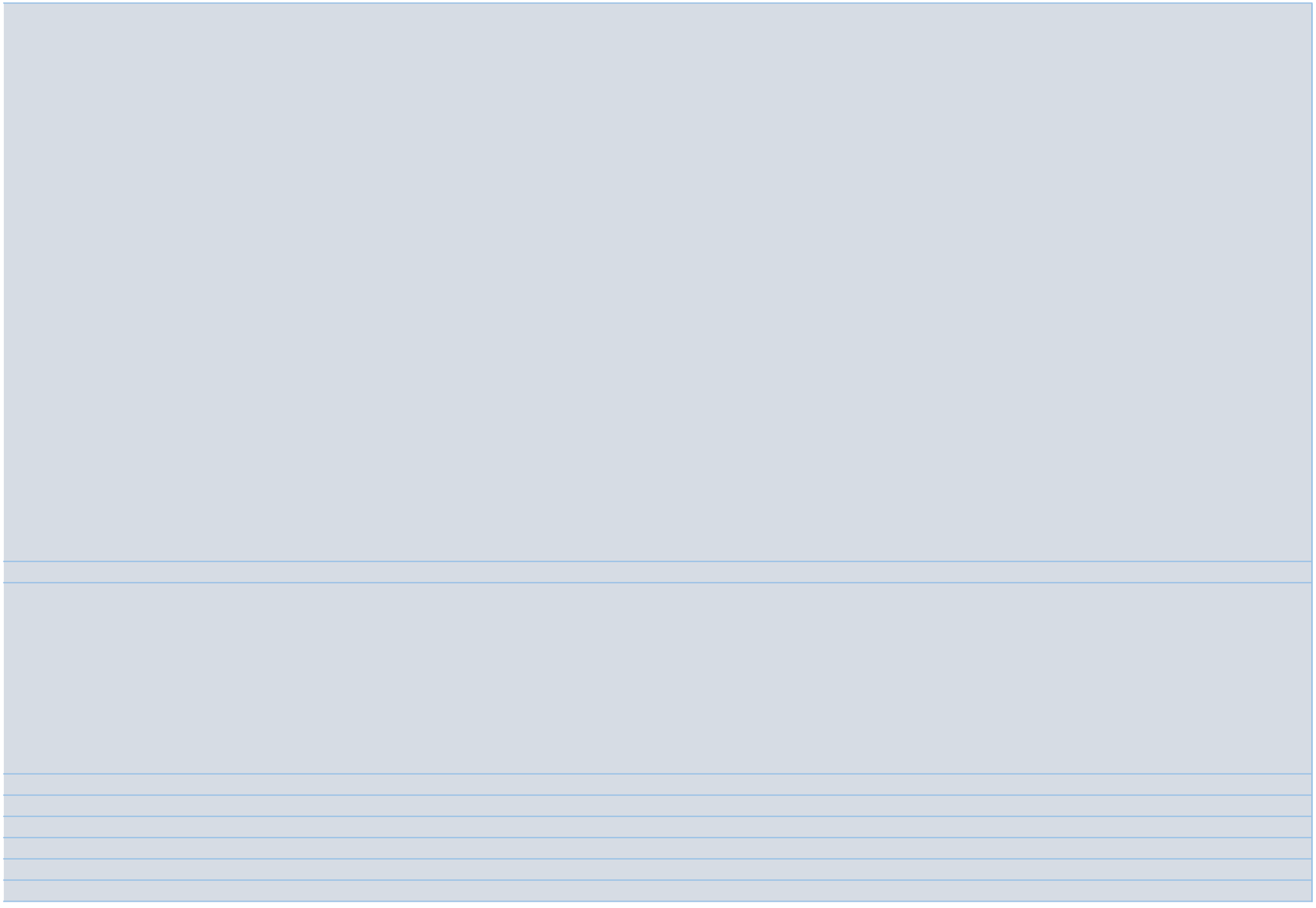

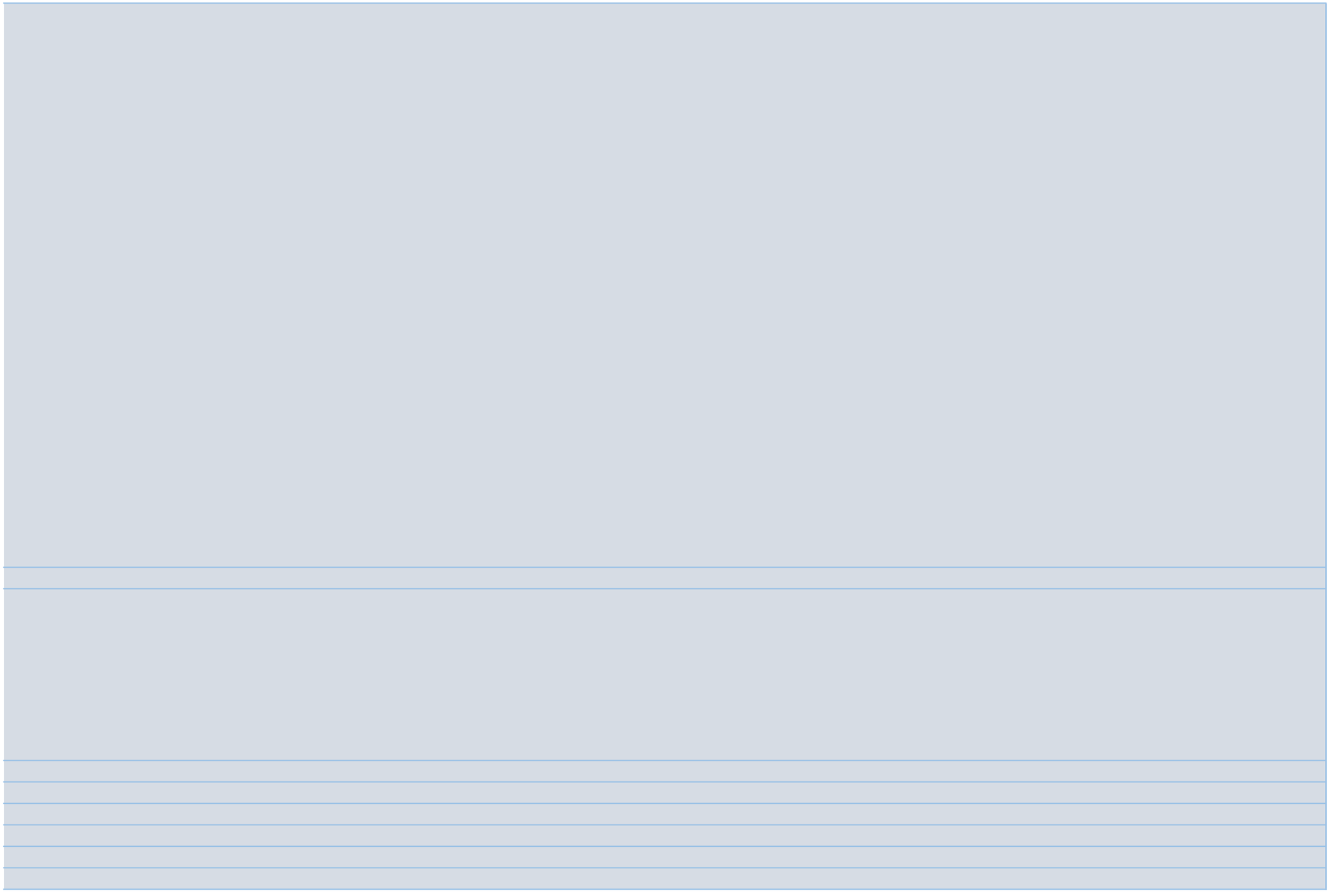

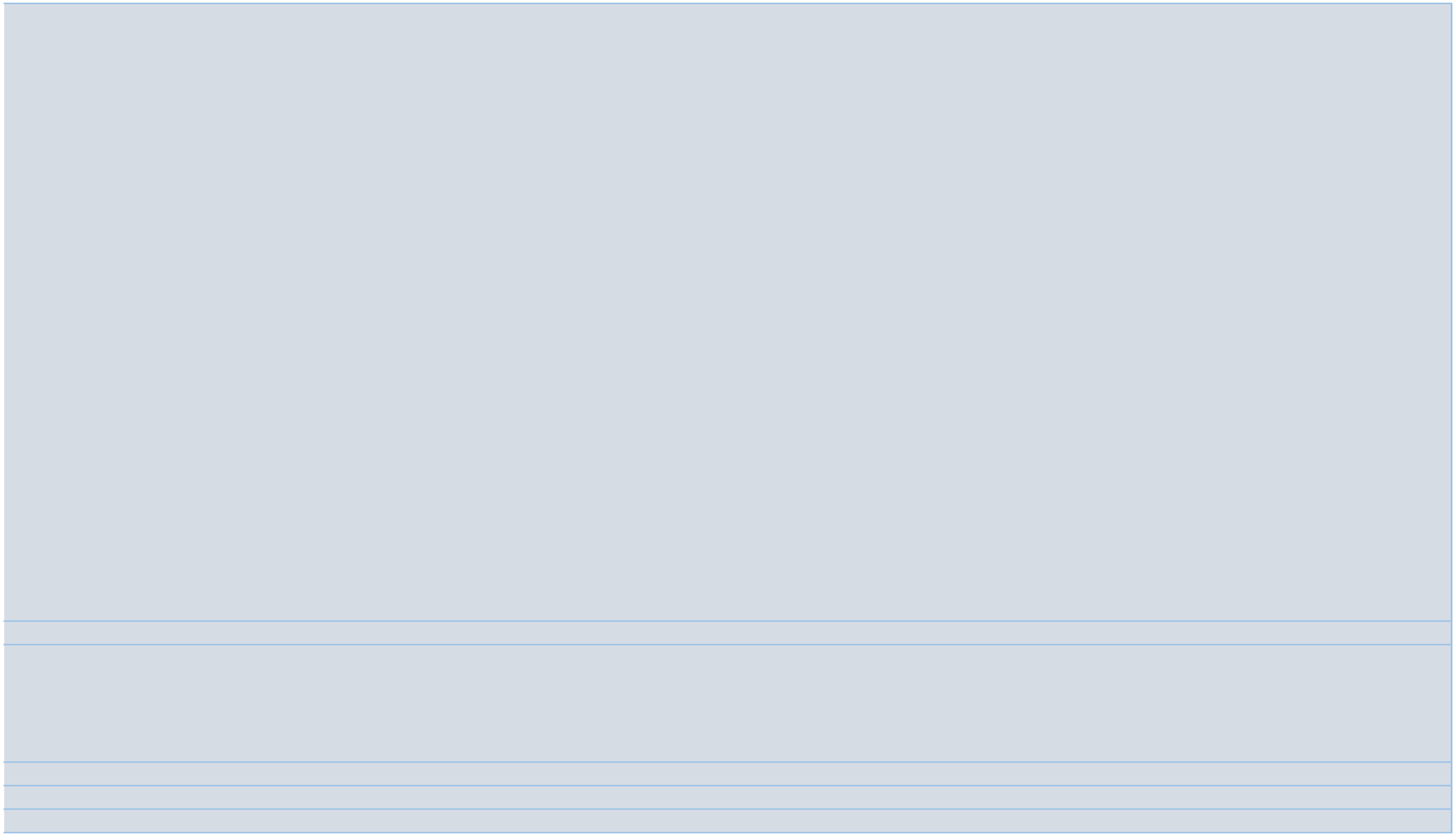

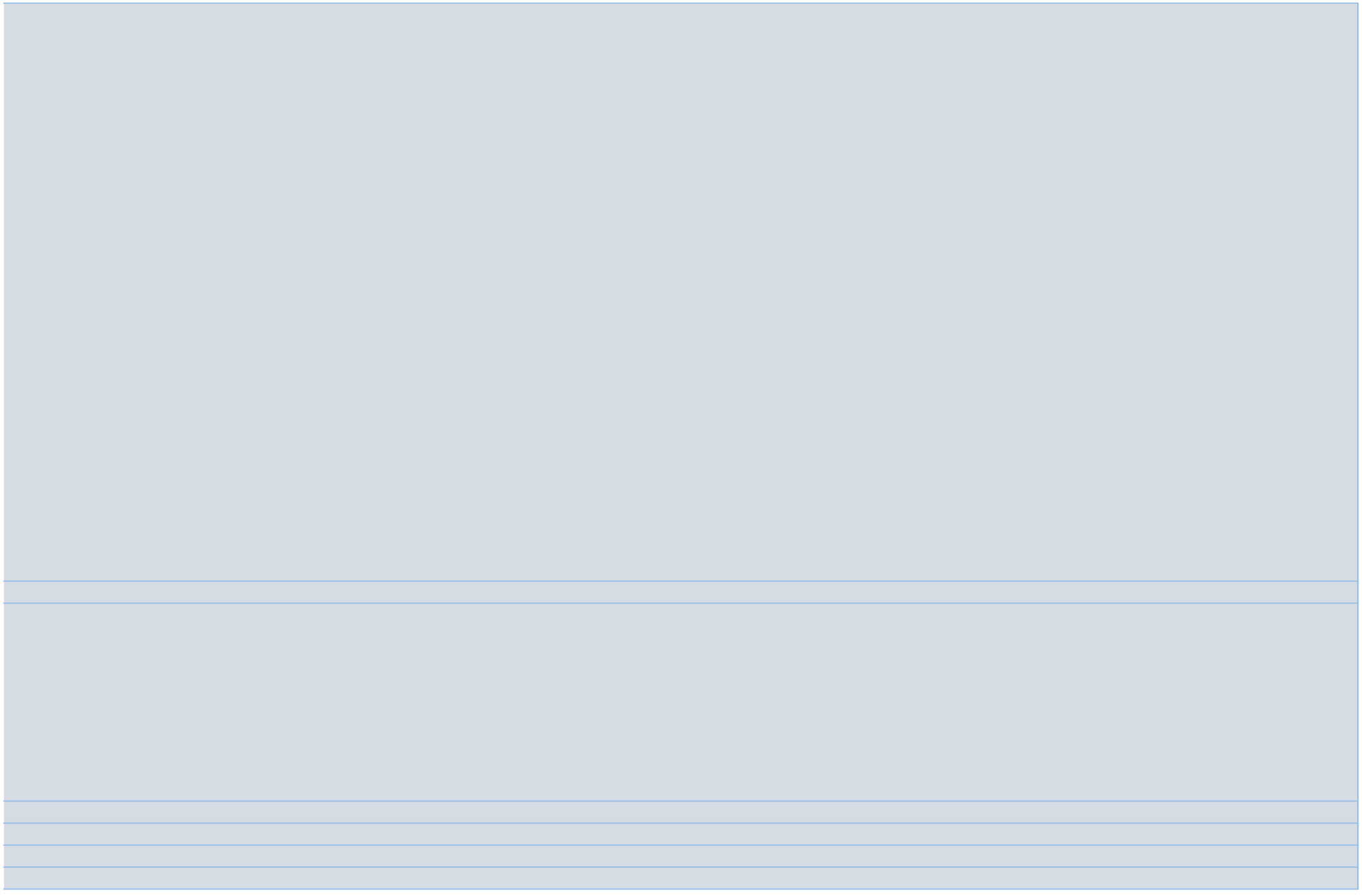

| | Due Date | Score | Status |
|---|---|---|---|
| | None | | In Progress |
| | None | 33 | Failed |

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|---|---|---|---|---|---|
| | | | | None | In Progress |
| | | | | None | In Progress |
| | | | | None | In Progress |

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|---|---|---|---|
| | | None | In Progress |
| | | None | In Progress |
| | | None | In Progress |
| | | None | In Progress |
| | | None | In Progress |
| | | None | In Progress |
| | | None | In Progress |
| | | None | 20 Failed |

| | | | |
|---|---|---|---|
| | None | | In Progress |
| | None | | Registered |
| | None | | In Progress |
| | None | 10 | Failed |
| | None | | In Progress |
| | None | | In Progress |
| | None | | Registered |

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|---|---|---|---|---|
| | | | None | In Progress |
| | | | None | In Progress |
| | | | None | Registered |
| | | | None | In Progress |
| | | | None | 50 In Progress |
| | | | None | Registered |

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|---|---|---|---|
| | | None | Registered |
| | | None | In Progress |
| | | None | In Progress |
| | | None | In Progress |
| | | None | 0 In Progress |
| | | None | In Progress |

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|---|---|---|---|
| | None | 0 | In Progress |
| | None | | In Progress |
| | None | | In Progress |
| | None | | In Progress |
| | None | 44 | Failed |
| | None | | In Progress |
| | None | 40 | In Progress |
| | None | | Pending Prerequisite |

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|---|---|---|---|---|
| | | | None | In Progress |
| | | | None | In Progress |
| | | | None | 20 In Progress |
| | | | None | Registered |
| | | | None | 28 In Progress |
| | | | None | In Progress |

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|---|---|---|---|---|
| | | | None | In Progress |
| | | | None | 0 In Progress |
| | | | None | In Progress |
| | | | None | 0 In Progress |
| | | | None | Registered |
| | | | None | 25 Failed |

| | | | | | |
|---|---|---|---|---|---|
| | | | | None | 0 In Progress |
| | | | | None | Registered |
| | | | | None | In Progress |
| | | | | None | 10 In Progress |
| | | | | None | 30 Failed |
| | | | | None | In Progress |

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|---|---|---|---|
| | None | | Exception Requested |
| | None | 30 | Failed |
| | None | | Registered |
| | None | 0 | In Progress |
| | None | | In Progress |
| | None | 0 | In Progress |

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|---|---|---|---|
| | | None | 0 In Progress |
| | | None | In Progress |
| | | None | Registered |
| | | None | In Progress |
| | | None | In Progress |
| | | None | Registered |

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|---|---|---|---|---|
| | | | None | Registered |
| | | | None | In Progress |
| | | | None | Registered |
| | | | None | 10 Failed |
| | | | None | In Progress |
| | | | None | Registered |
| | | | None | Registered |
| | | | None | Registered |
| | | | None | In Progress |

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|---|---|---|---|---|
| | | | None | In Progress |
| | | | None | In Progress |
| | | | None | Registered |
| | | | None | 11 Failed |
| | | | None | 67 Failed |
| | | | None | 20 In Progress |

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|---|---|---|---|---|
| | | | None | 13 In Progress |
| | | | None | Registered |
| | | | None | Pending Prerequisite |
| | | | None | Registered |
| | | | None | 20 In Progress |

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|---|---|---|---|---|
| | | None | | Pending Prerequisite |
| | | None | | Pending Prerequisite |
| | | None | | Registered |
| | | None | 0 | In Progress |
| | | None | 24 | Failed |
| | | None | | Registered |
| | | None | 40 | Failed |

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|---|---|---|---|---|---|
| | | | | None | Registered |
| | | | | None | 0 In Progress |
| | | | | None | 0 In Progress |
| | | | | None | 0 In Progress |

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|---|---|---|---|
| | | None | 0 In Progress |
| | | None | 0 In Progress |
| | | None | 0 In Progress |
| | | None | 0 In Progress |
| | | None | 0 In Progress |

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|---|---|---|---|---|
| | | | None | In Progress |
| | | | None | In Progress |
| | | | None | In Progress |
| | | | None | 0 In Progress |
| | | | None | 0 In Progress |

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|---|---|---|---|---|
| | | | None | Registered |
| | | | None | In Progress |
| | | | None | 30 Failed |
| | | | None | Registered |
| | | | None | Registered |
| | | | None | 0 In Progress |
| | | | None | In Progress |

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|---|---|---|---|
| | | None | Registered |
| | | None | In Progress |
| | | None | Registered |
| | | None | In Progress |
| | | None | Registered |

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| | | | None | Registered |
| | | | None | Registered |
| | | | None | 42 Failed |
| | | | None | 40 In Progress |
| | | | None | Registered |
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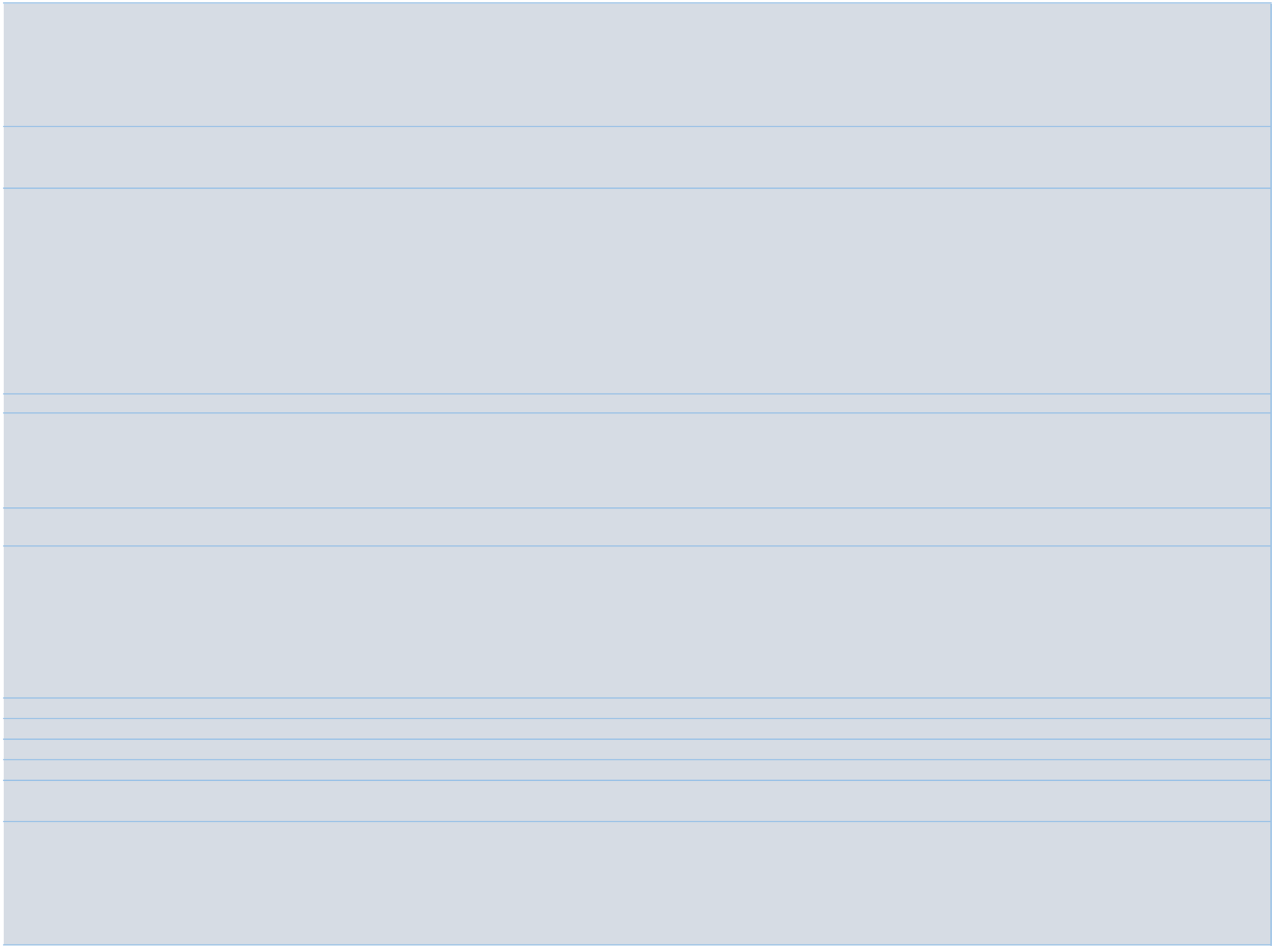

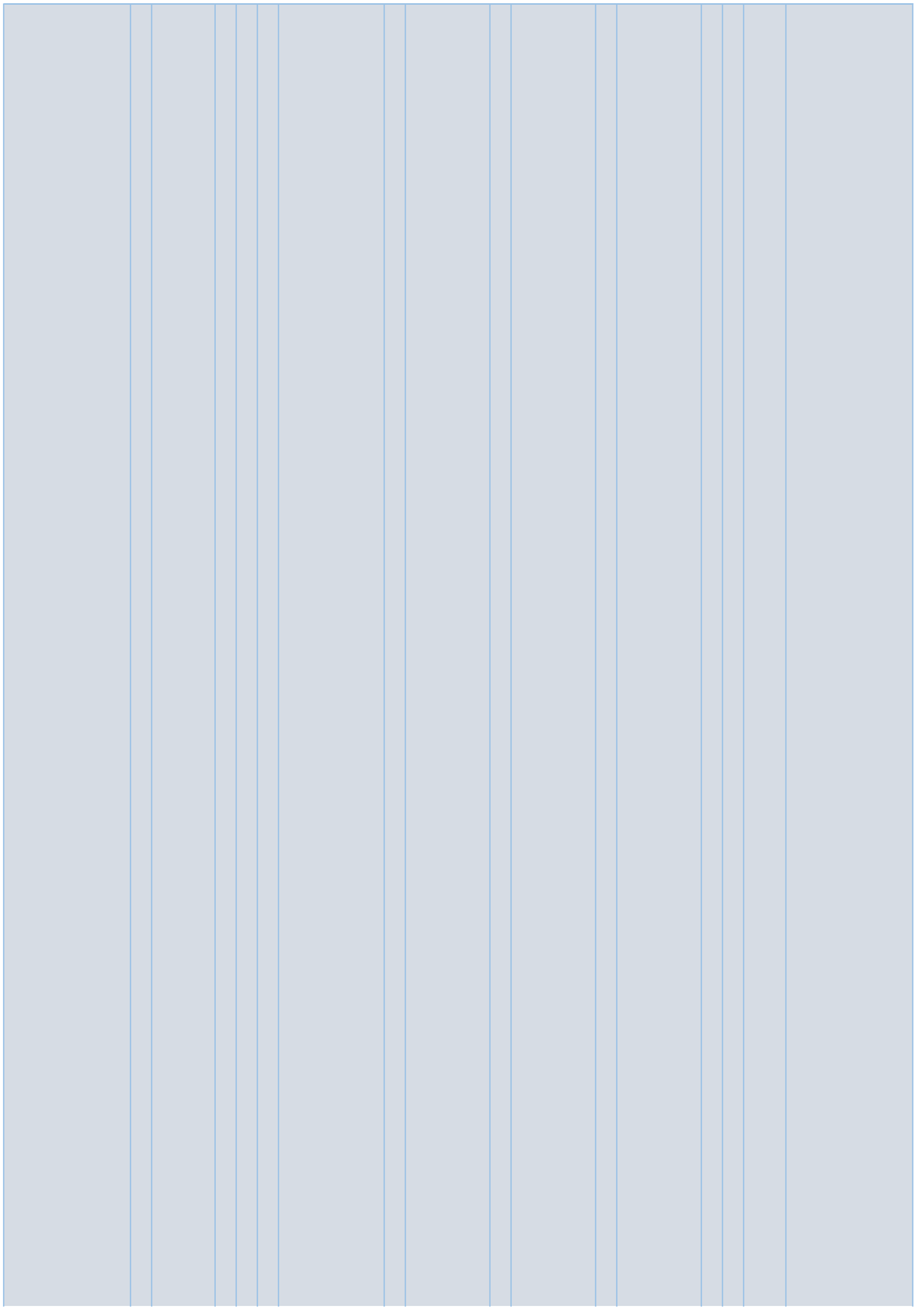

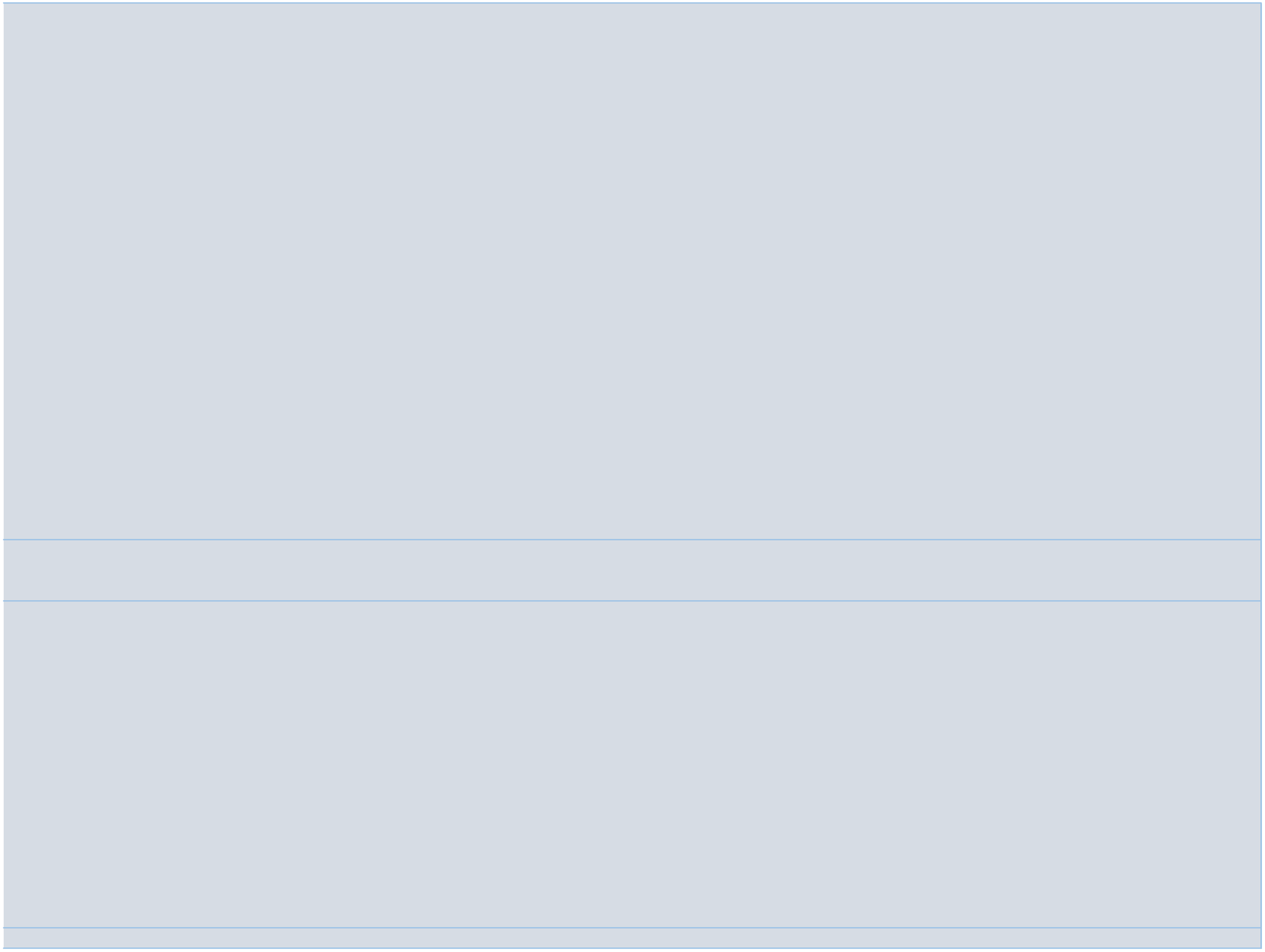

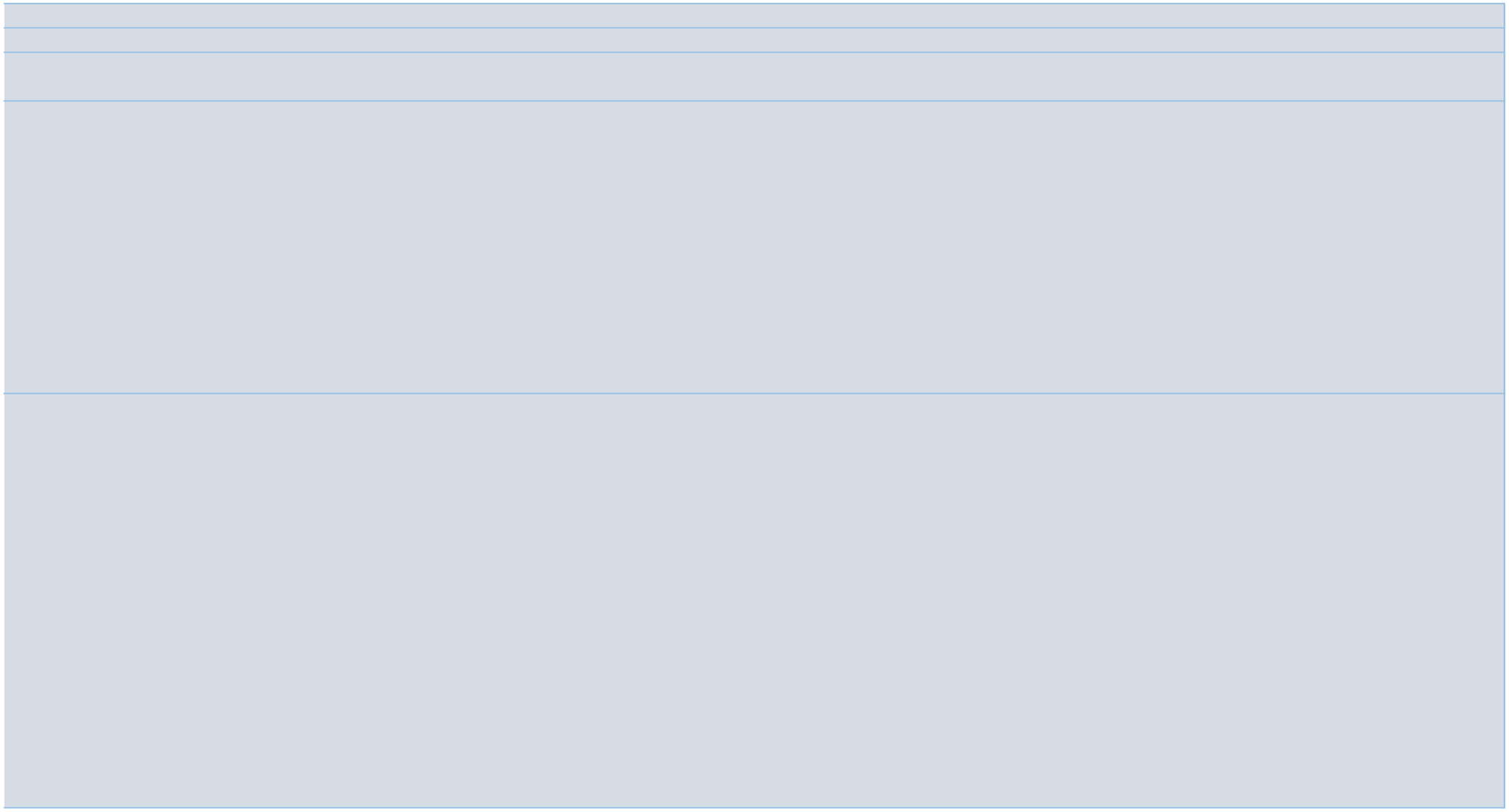

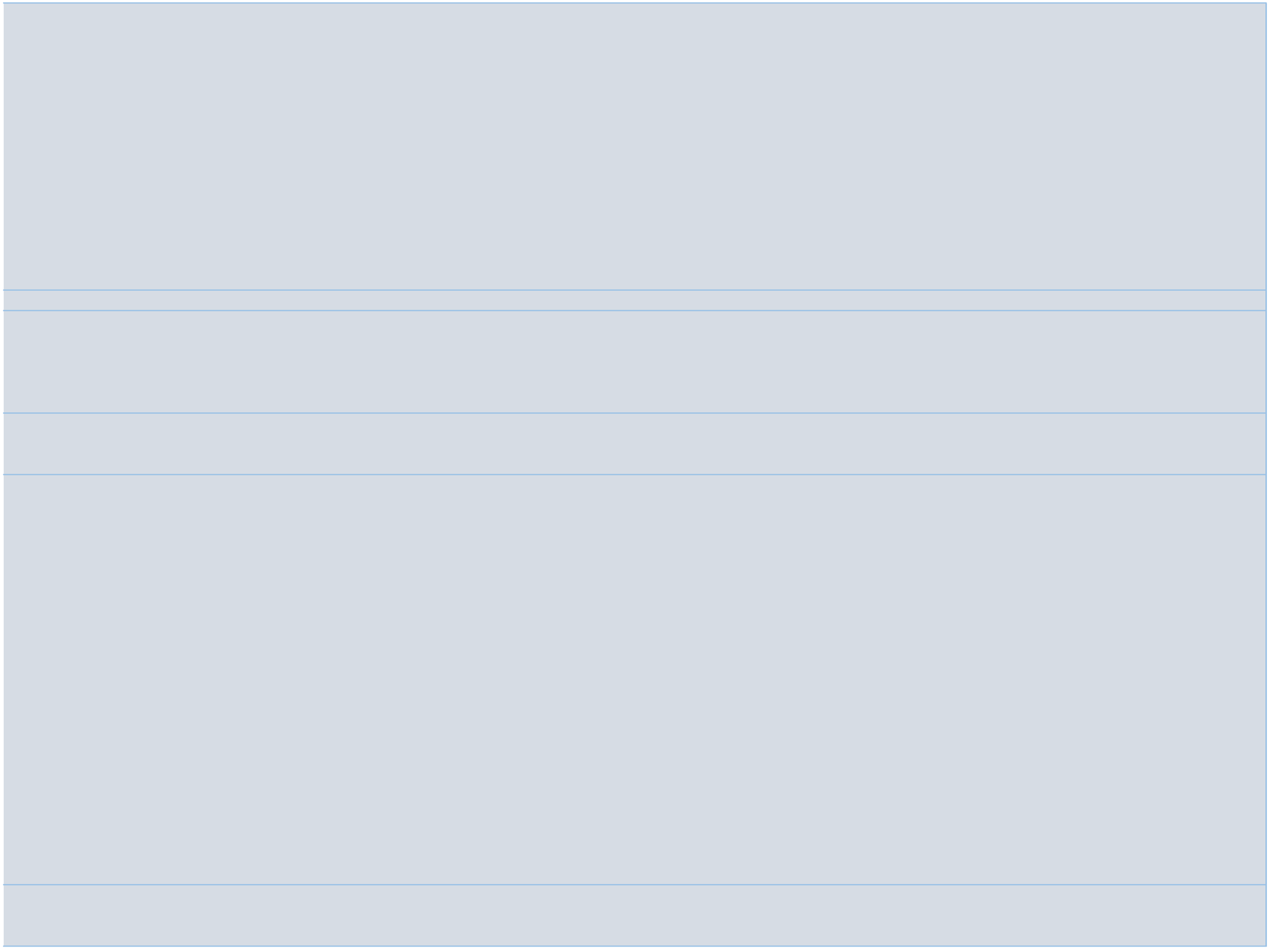

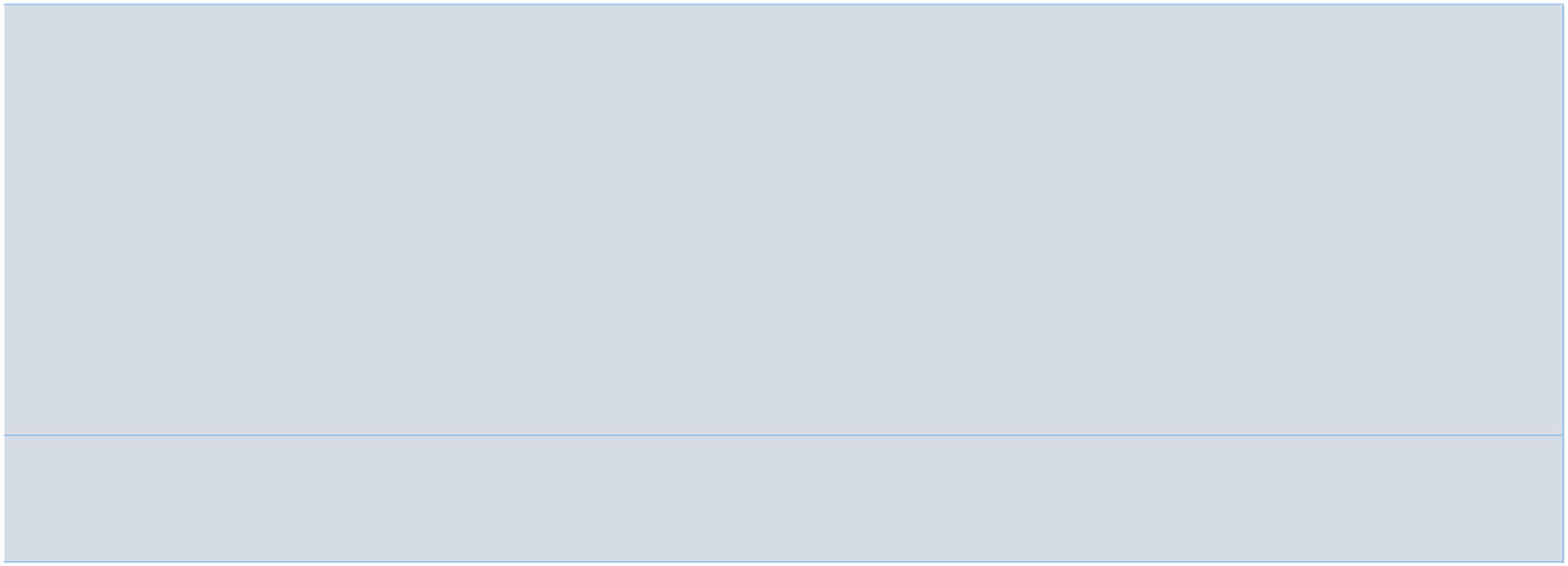

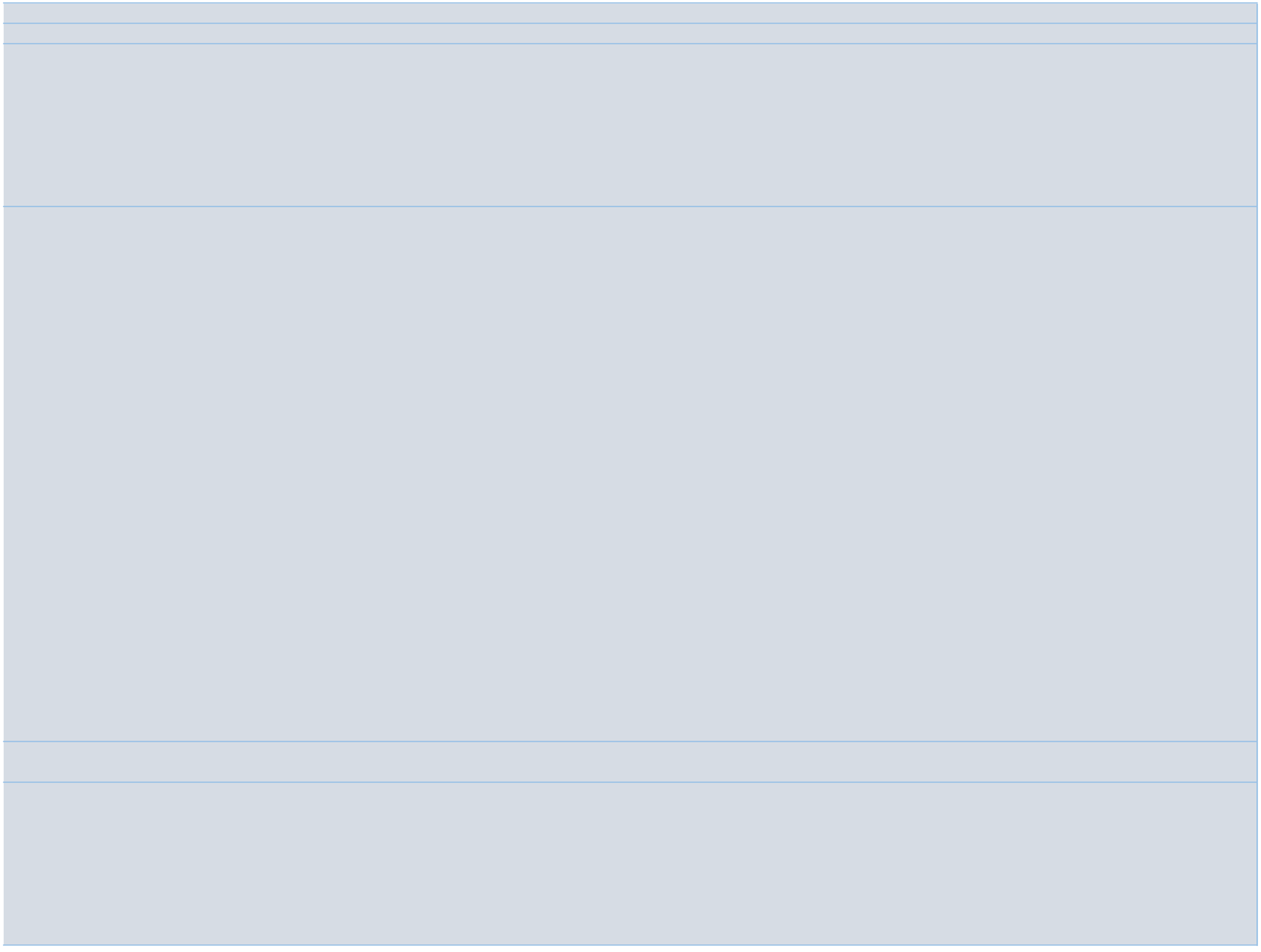

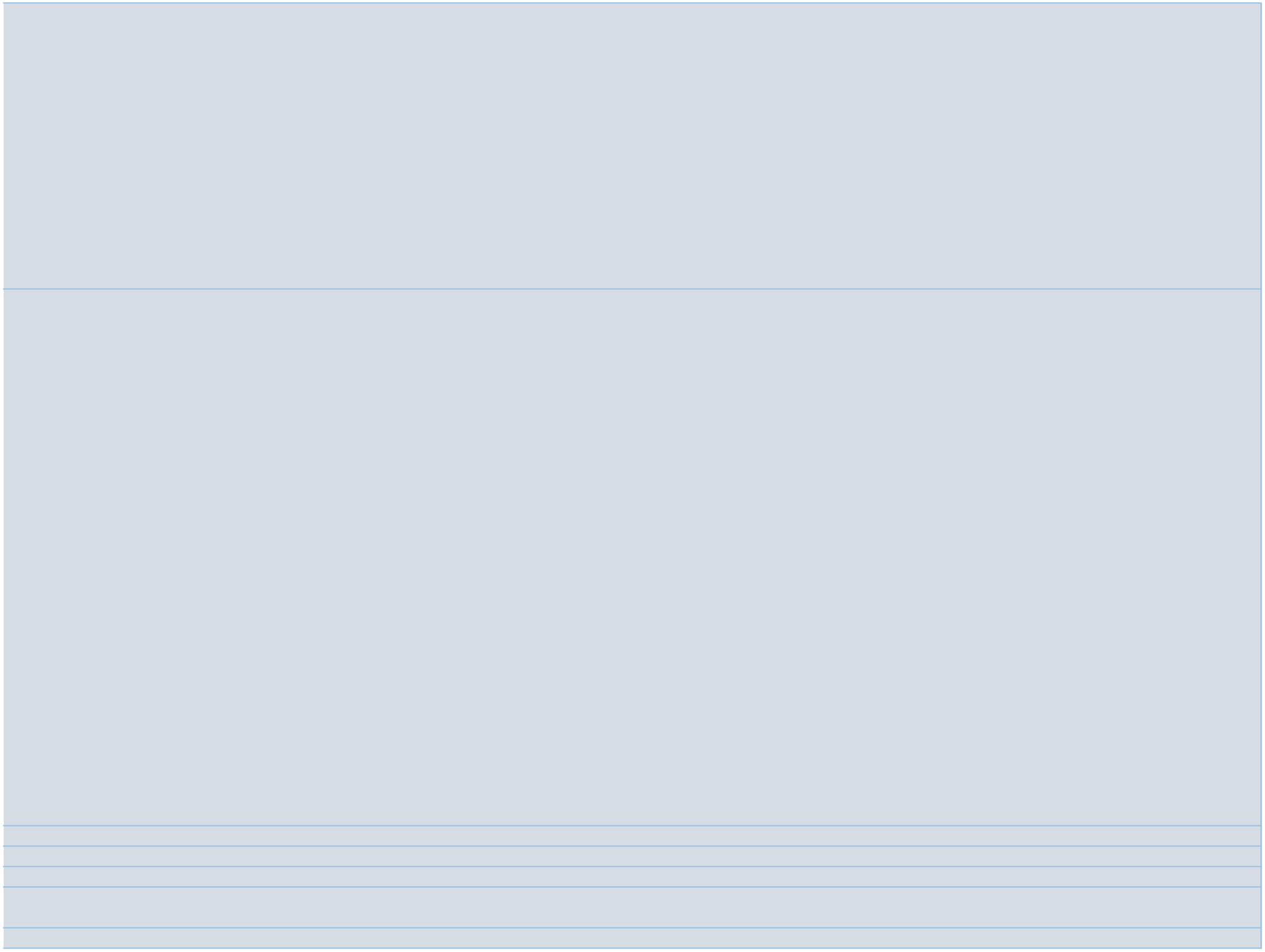

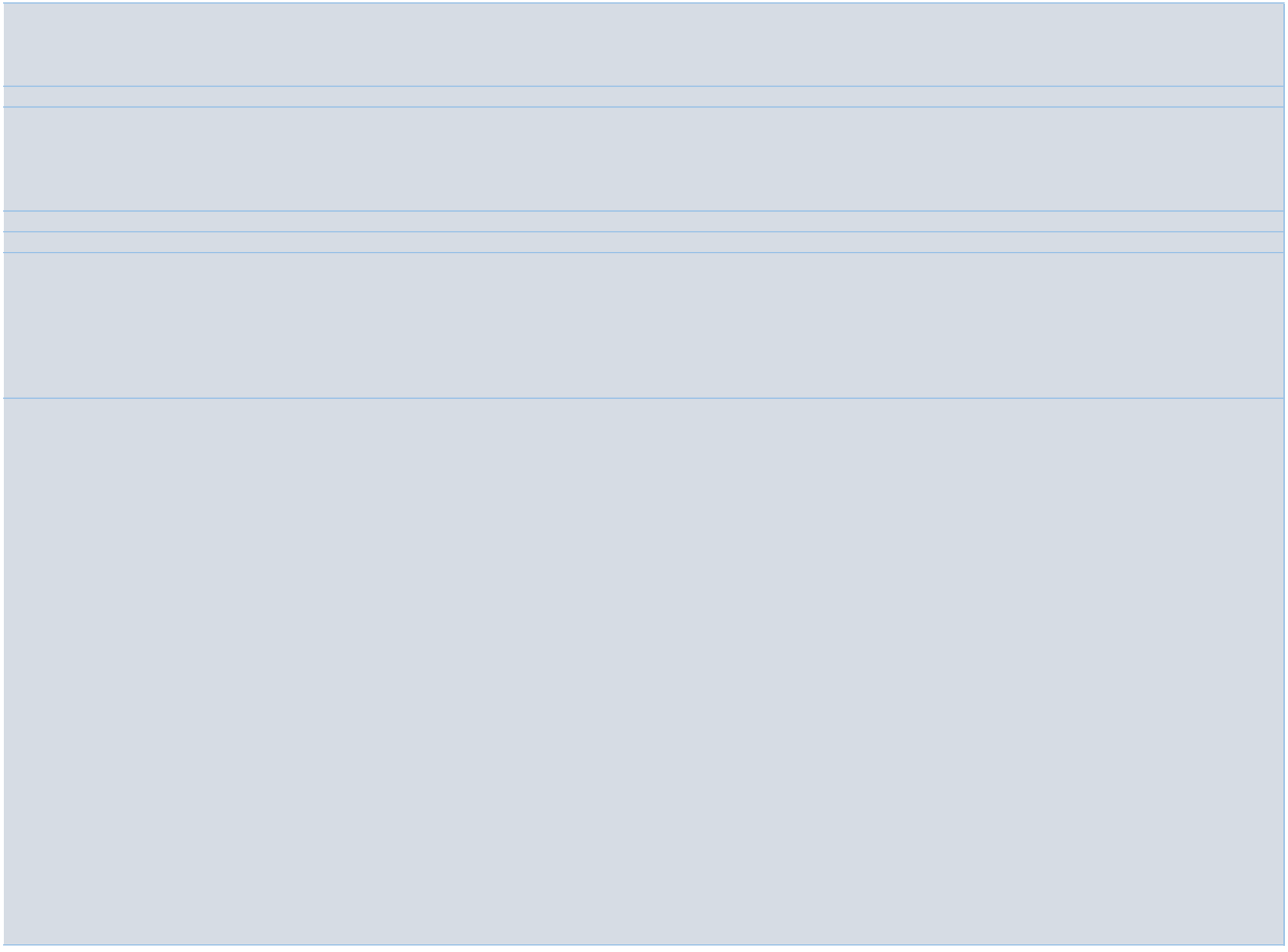

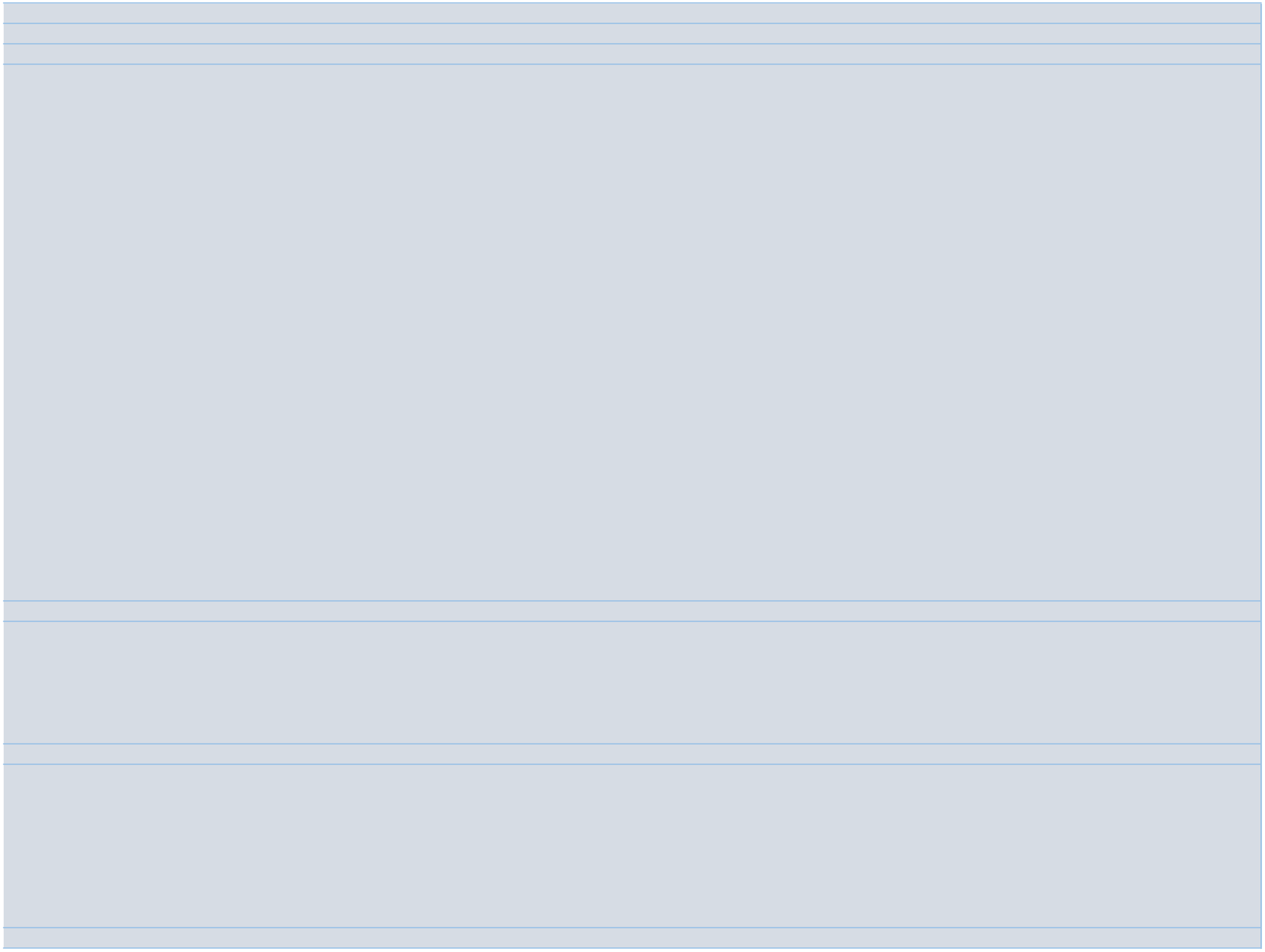

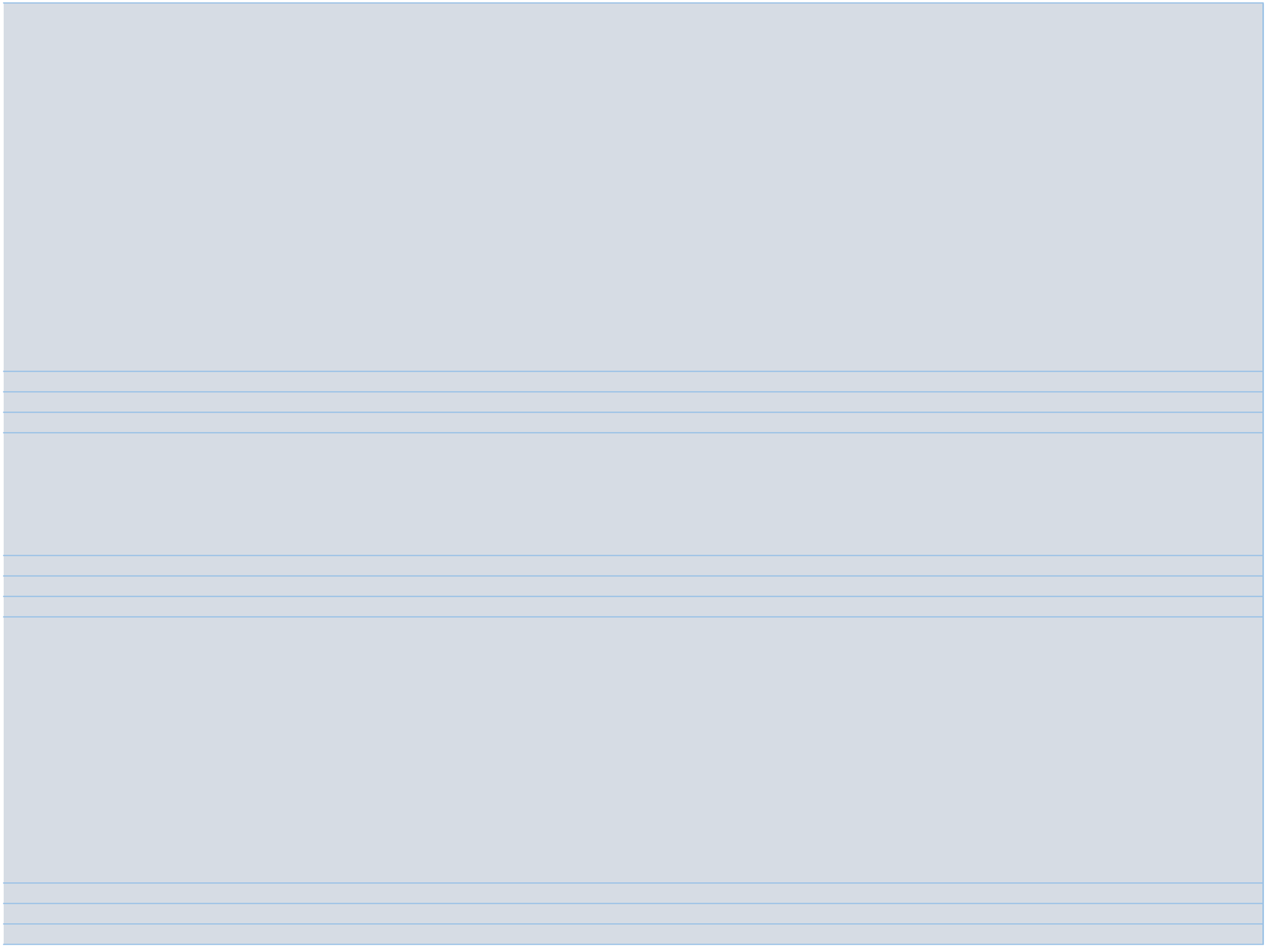

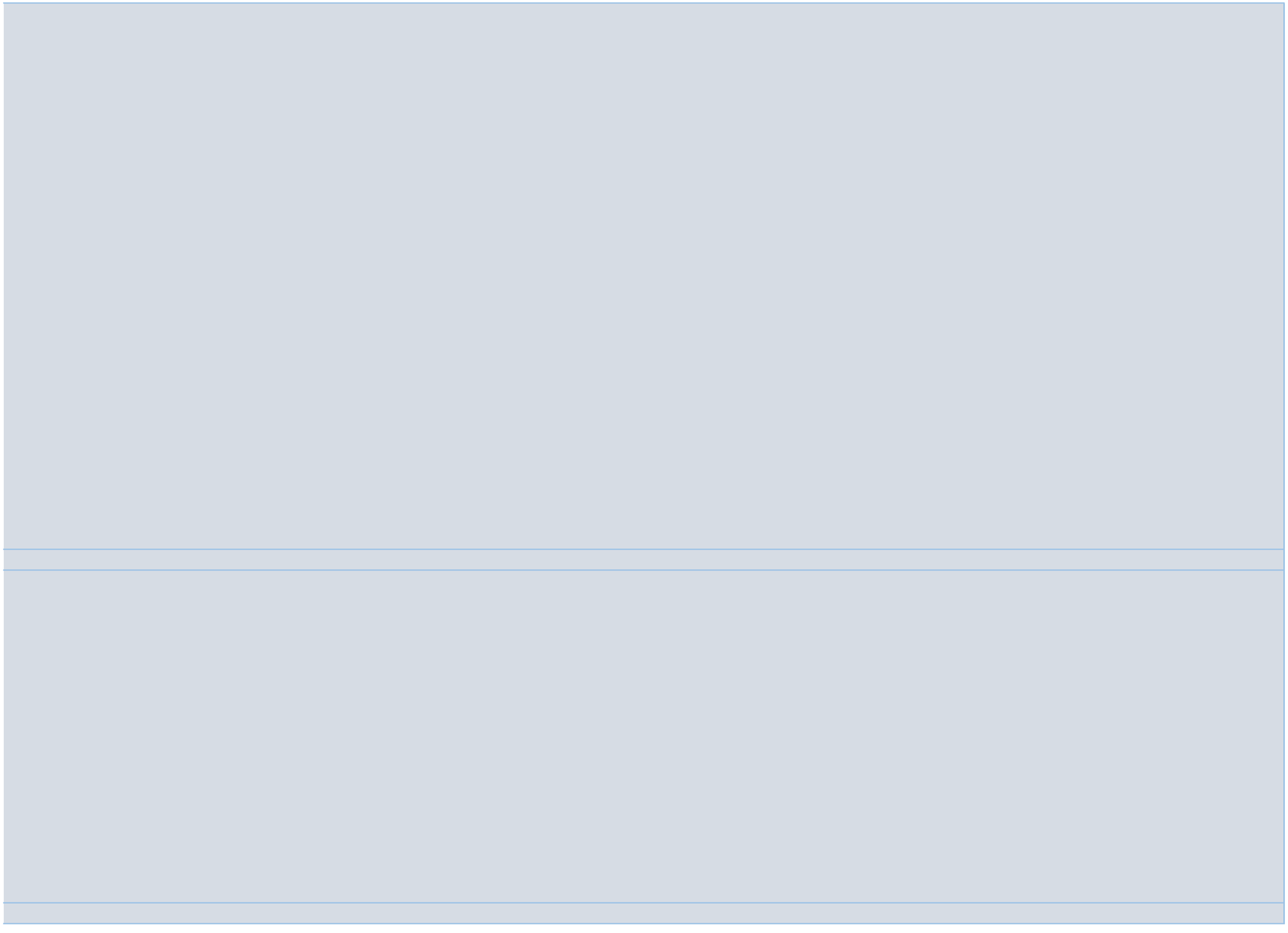

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| | | Completion Date | Score | Status |

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|---|---|---|---|---|
| | | 9/20/2024 | | Completed |
| | | 9/20/2024 | | Completed |
| | | 9/20/2024 | | Completed |
| | | 8/12/2024 | | Completed |
| | | 3/5/2024 | | Completed |
| | | 1/24/2024 | | Completed |
| | | 1/24/2024 | | Completed |

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| | | 1/23/2024 | | Completed |
| | | 1/23/2024 | | Completed |
| | | 1/23/2024 | | Completed |
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| | | 1/23/2024 | | Completed |
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| | | 1/21/2024 | | Completed |
| | | 1/18/2024 | | Completed |
| | | 1/18/2024 | | Completed |
| | | 1/15/2024 | | Completed |
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| | | 1/15/2024 | | Completed |
| | | 1/15/2024 | | Completed |
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| | | 1/15/2024 | | Completed |
| | | 1/15/2024 | | Completed |
| | | 1/15/2024 | | Completed |
| | | 1/15/2024 | | Completed |
| | | 1/14/2024 | | Completed |
| | | 1/14/2024 | | Completed |

| | | | | |
|---|---|---|---|---|
| | | 1/13/2024 | | Completed |
| | | 1/13/2024 | 0 | Completed |
| | | 1/13/2024 | | Completed |
| | | 1/13/2024 | | Completed |
| | | 1/12/2024 | 0 | Completed |

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|---|---|---|---|---|
| | | 1/12/2024 | | Completed |
| | | 1/12/2024 | | Completed |
| | | 1/12/2024 | | Completed |
| | | 1/12/2024 | | Completed |
| | | 1/12/2024 | | |
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| | |
| Curriculum | |
| Home and<br>Distribution<br>Academy | |
| 30.0<br>Structure<br>History | |
| 3 Hours 39<br>Minutes | |

| | |
|---|---|
| Schneider Home Certification training is designed to equip installers with the knowledge and skills required to successfully deploy Schneider Electric's newest innovation in home energy managemen t, the Schneider Home energy managemen t system. | |
| | |

| | |
|---|---|
| This course delivers in-depth and comprehensive instruction on everything you need to know on how to properly install and commission Schneider Home suite of products. It covers the following topics: | |
| | |
| • Installing and wiring Schneider Inverter, and Boost, Pulse Backup Controller - wall mount. | |
| | |

| | |
|---|---|
| • Installing Schneider Energy Monitor and Square D Relays (if installing Schneider Energy Monitor in Pulse Backup Controller) | |
| | |
| • Commissioning with eSetup App and Smart Panel Setup App | |
| | |
| • Using Schneider Electric Installer Portal | |
| | |
| • Preparing for Handoff to the Homeowner | |
| | |

| | |
|---|---|
| • Accessing Schneider Home Resources | |
| | |
| • RMA Instructions and Warranties | |
| | |
| • Contactin g Technical Support | |
| | |
| | |
| | |
| At the end of the course, you will take a 25-point Certification Test. You must obtain an 80% passing score to receive your Schneider Home Certification . | |

This course
offers 3
NABCEP
CEU credits.

Course
Code: HDAP
RDCS00010
05

In Progress

None

Curriculum

Select a
training

raining

vated
Training

Not
Activated
Training
Show
Expired
Training

| Title (Click on | Type | Due Date | Excused | Required | Status | Options | Details |
|---|---|---|---|---|---|---|---|
| to see course description) | | | | | | | |
| Schneider Home Certification courses (Min. required: 10) | Section | | | | | | None |
| | | | | | | | |
| | | | | | | | |
| Introduction to Schneider Home | Online Class | None | No | | Completed (Equivalent) | unch \| Regis | |
| | | | | | | | |
| | | | | | | | |
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| Schneider Inverter | Online Class | None | No | | Not Activated | Activate | None |
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| Schneider Boost | Online Class | None | No | | Pending Prior Training | None | None |
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|---|---|---|---|---|---|---|---|---|
| Pulse Backup Controller | Online Class | None | No | | Pending Prior Training | None | None | |
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| Load Control | Online Class | None | No | | Pending Prior Training | None | None | |
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| Commissioning with Schneider Smart Panel Setup App | Online Class | None | No | | Pending Prior Training | None | None | |
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| | | | | | | | | |
| Commissioning with eSetup App | Online Class | None | No | | Pending Prior Training | None | None | |
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|---|---|---|---|---|---|---|---|---|---|
| | Schneider Home Handoff to Homeowners | Online Class | None | No | | Pending Prior Training | None | None | |
| | | | | | | | | | |
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| | | | | | | | | | |
| | Schneider Electric Installer Portal | Online Class | None | No | | Pending Prior Training | None | None | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | Schneider Home Support for Installers | Online Class | None | No | | Pending Prior Training | None | None | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | Schneider Home Certification Test (Min. required: 1) | Section | | | | | | None | |
| | | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| Schneider Home Certification Test | Online Class | None | No | | Pending Prior Training | None | None | |
| | | | | | | | | |
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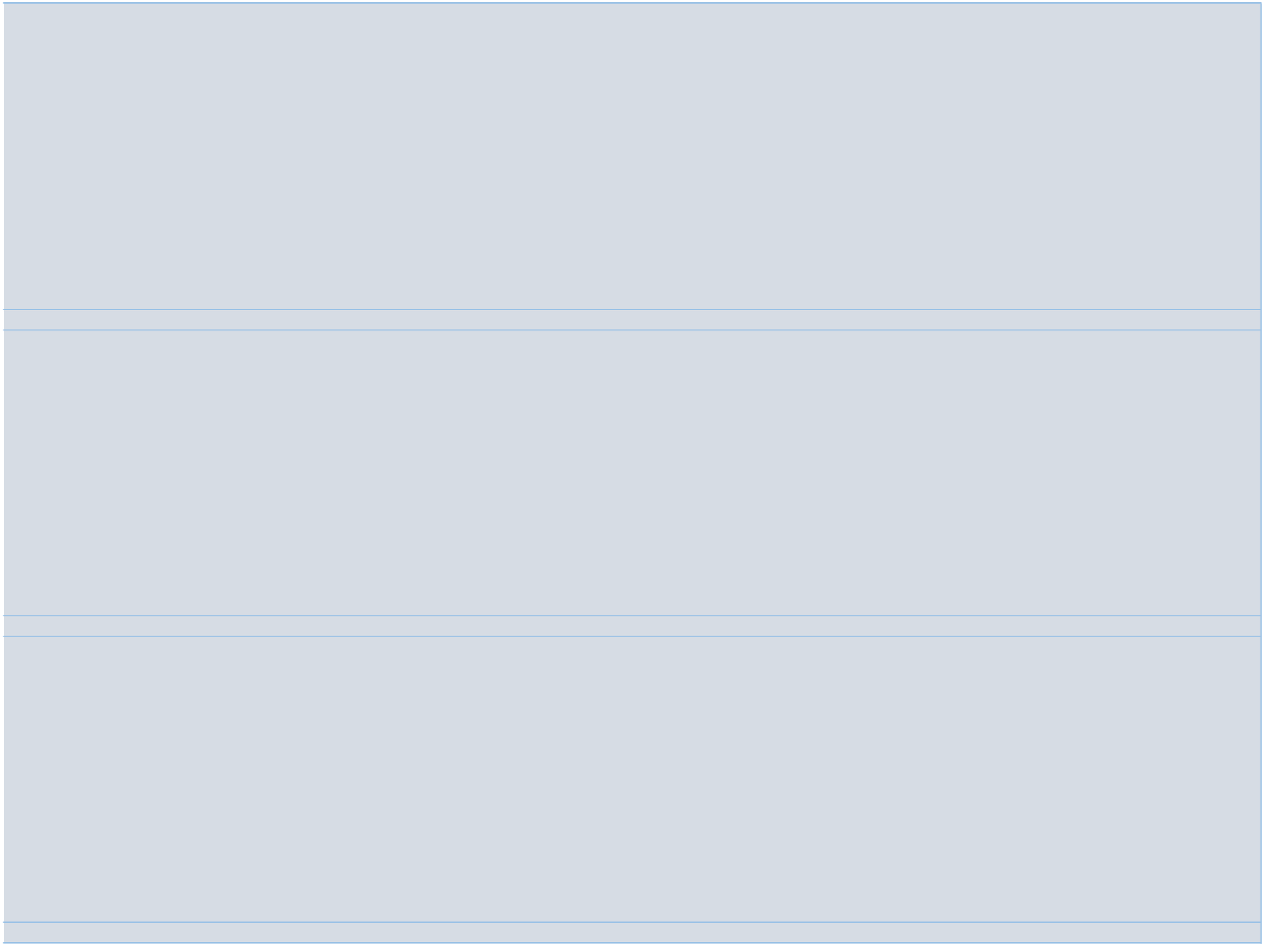
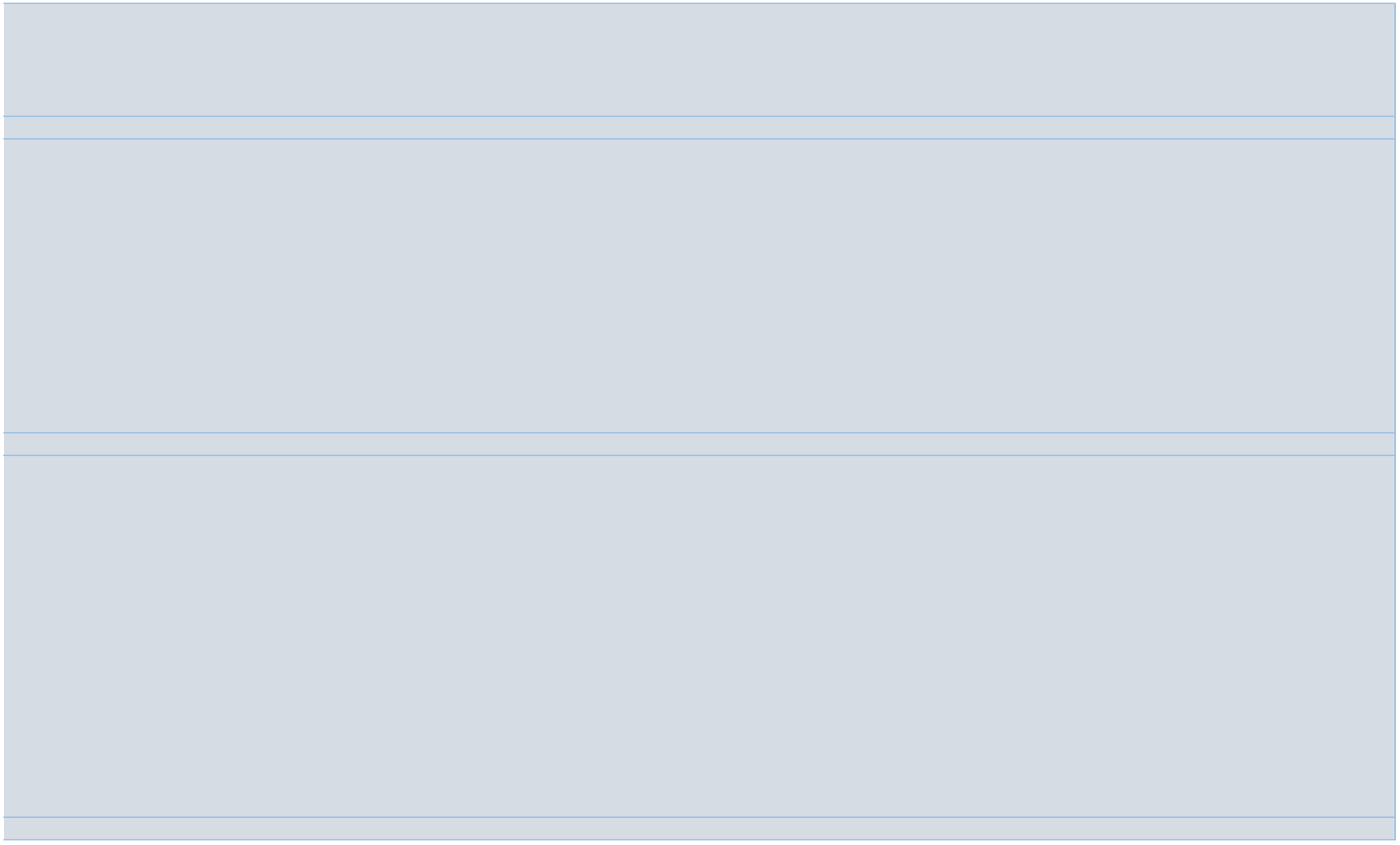
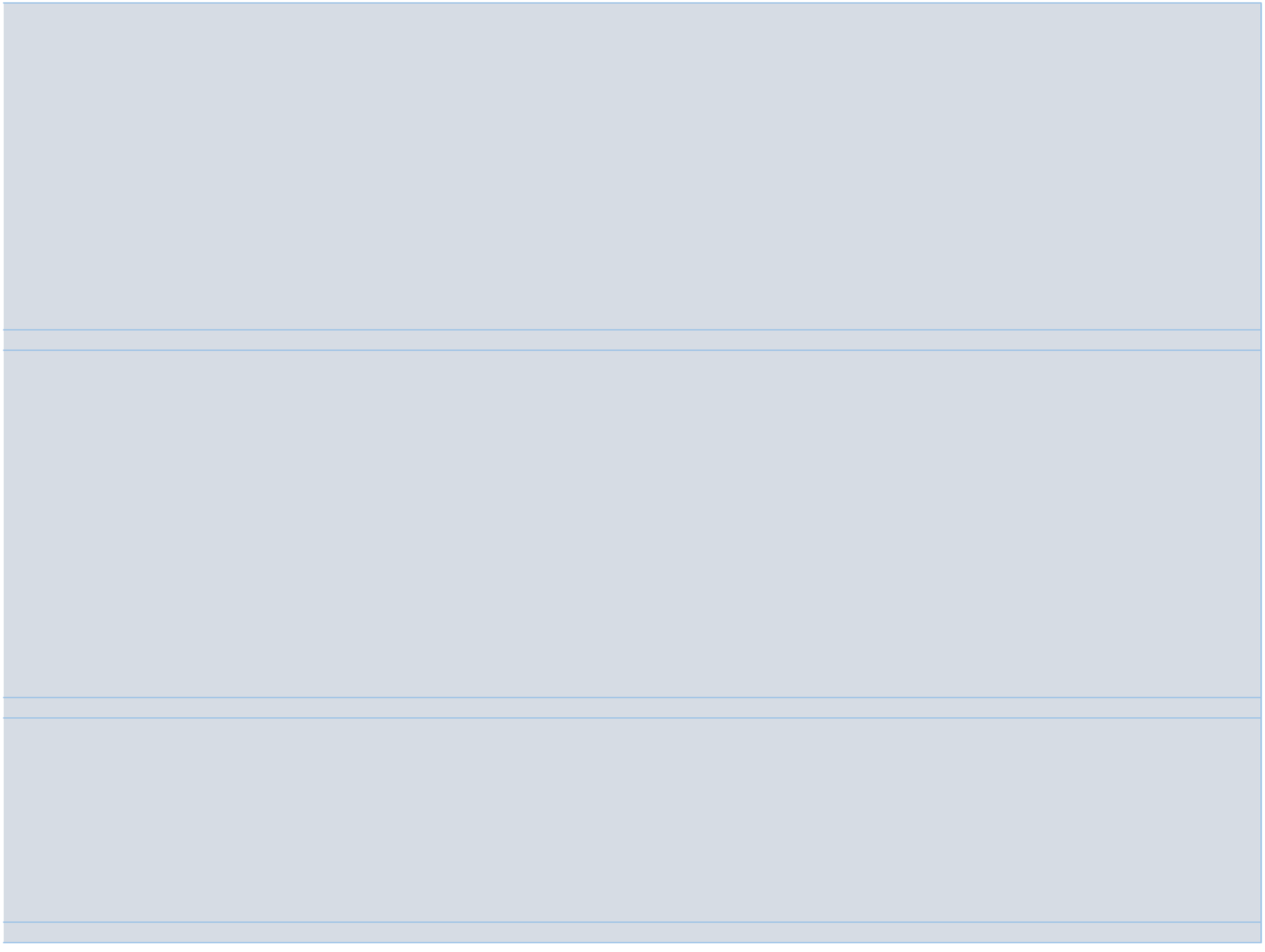
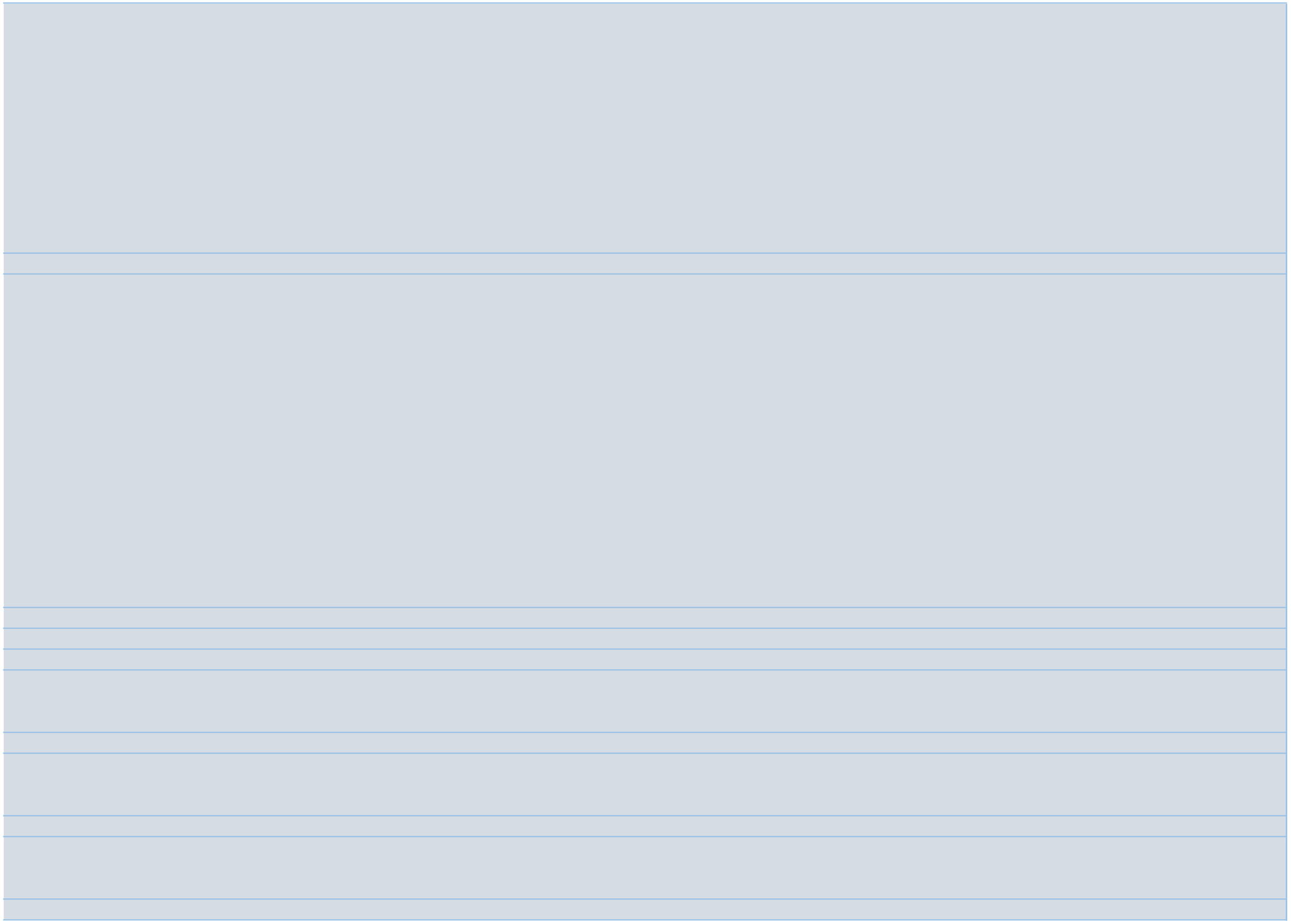
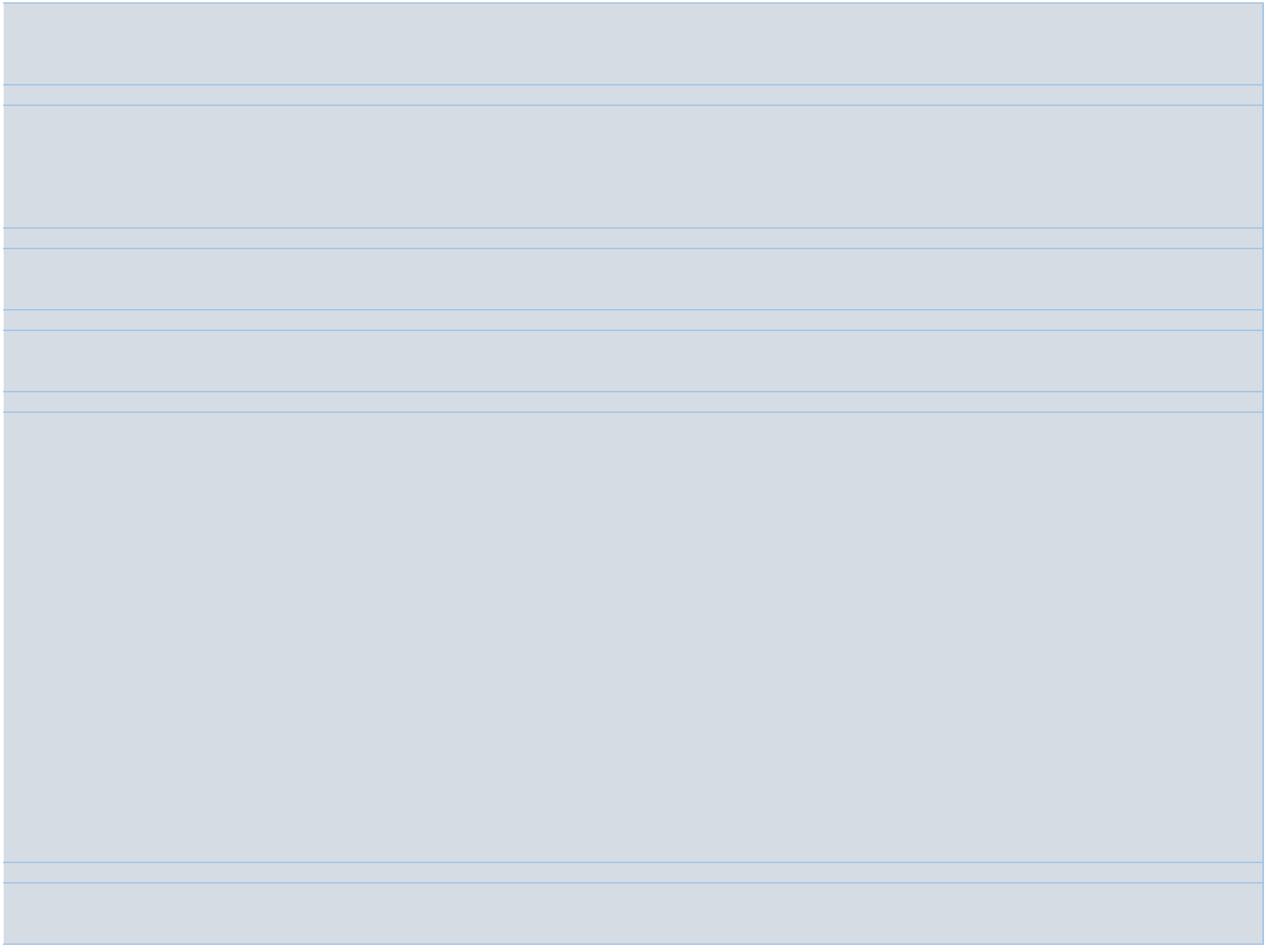
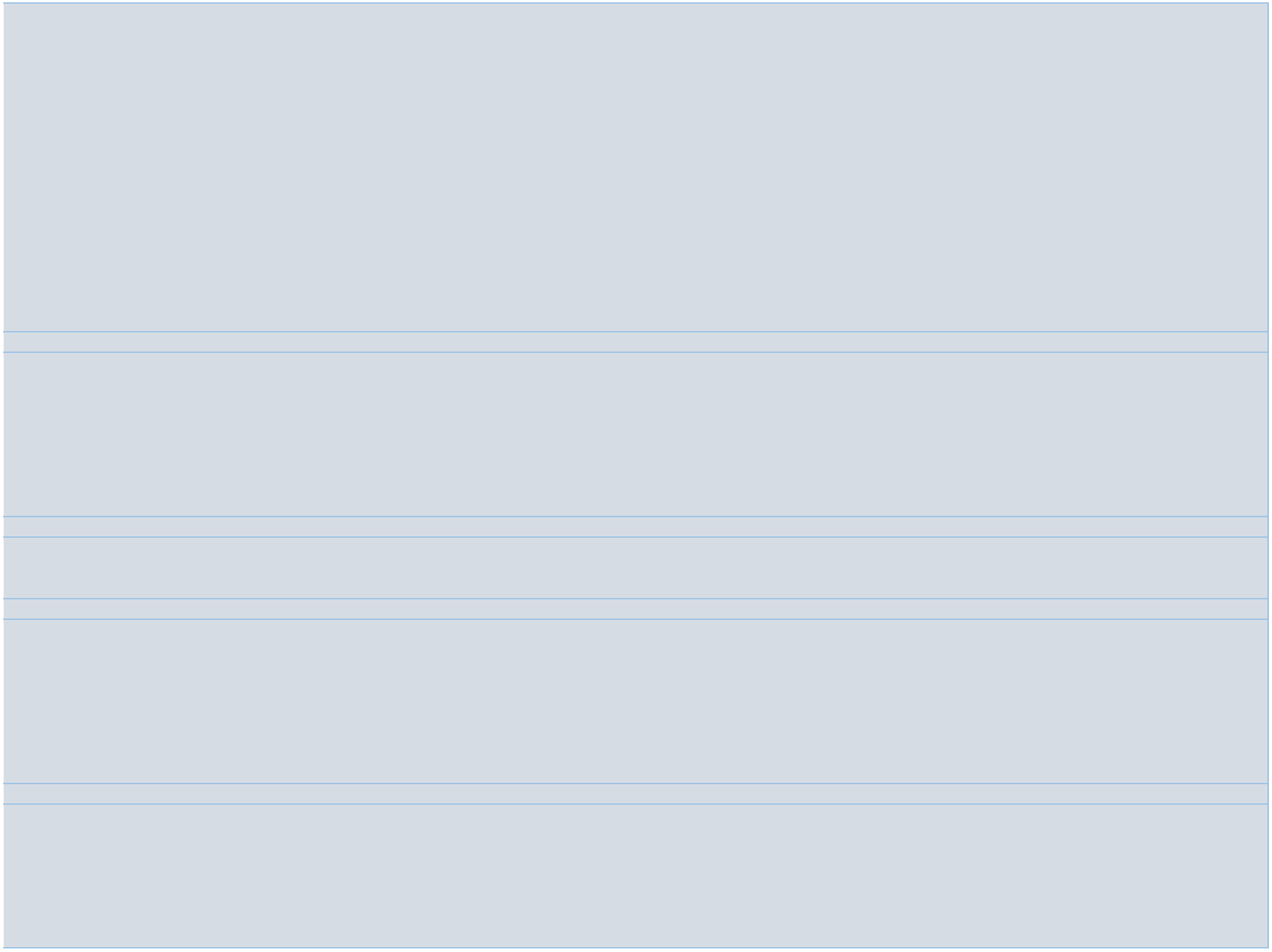


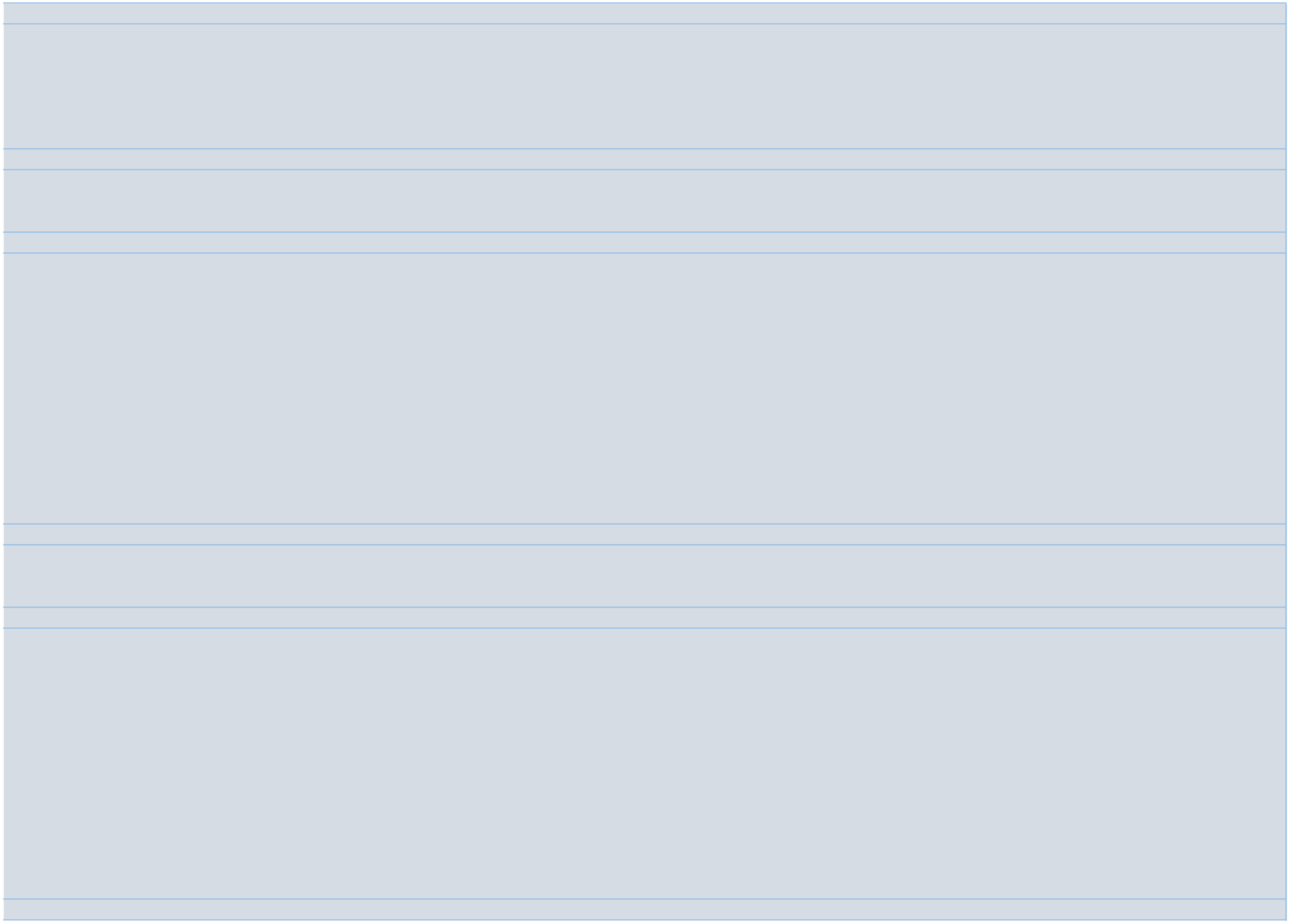


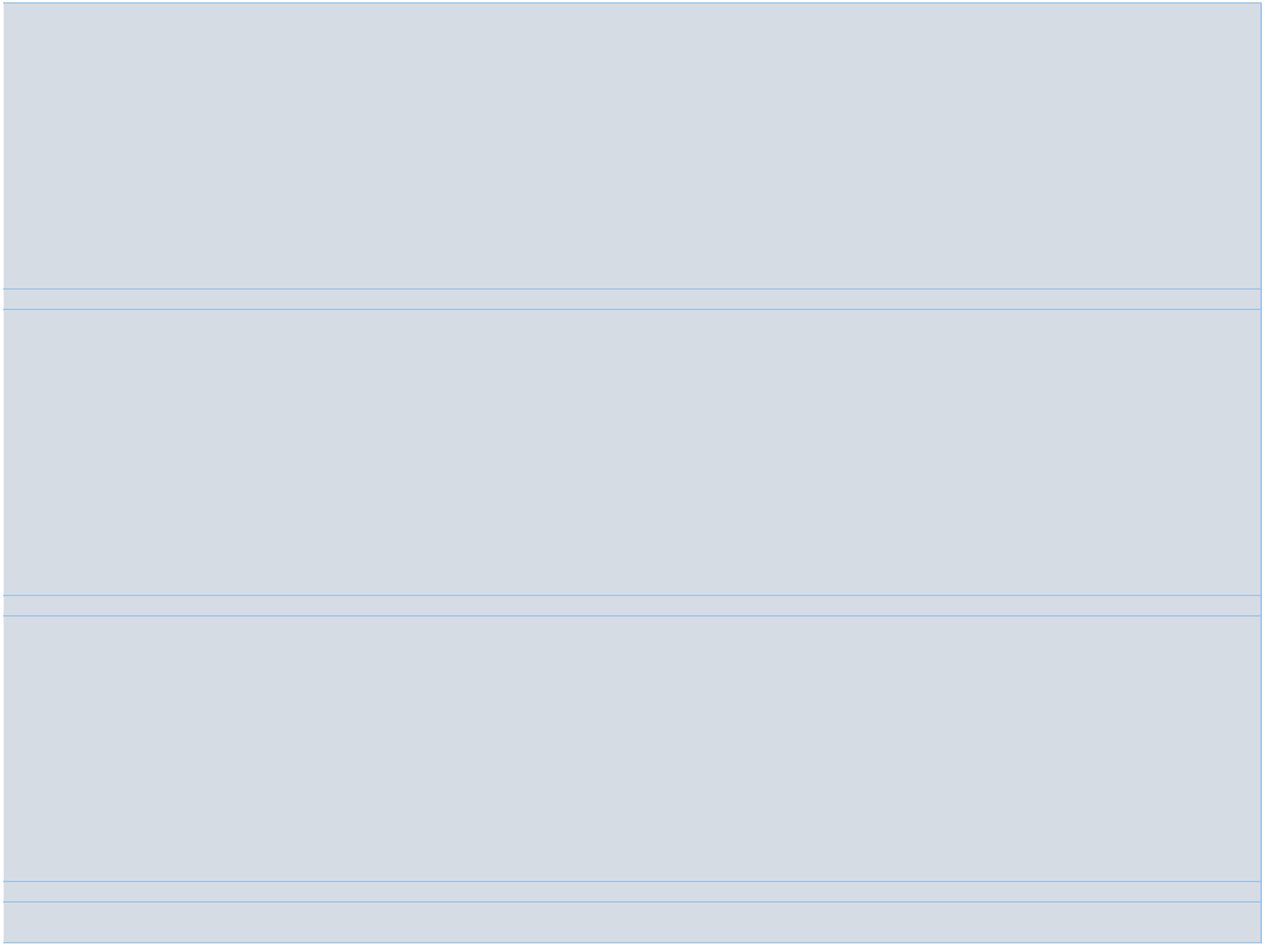


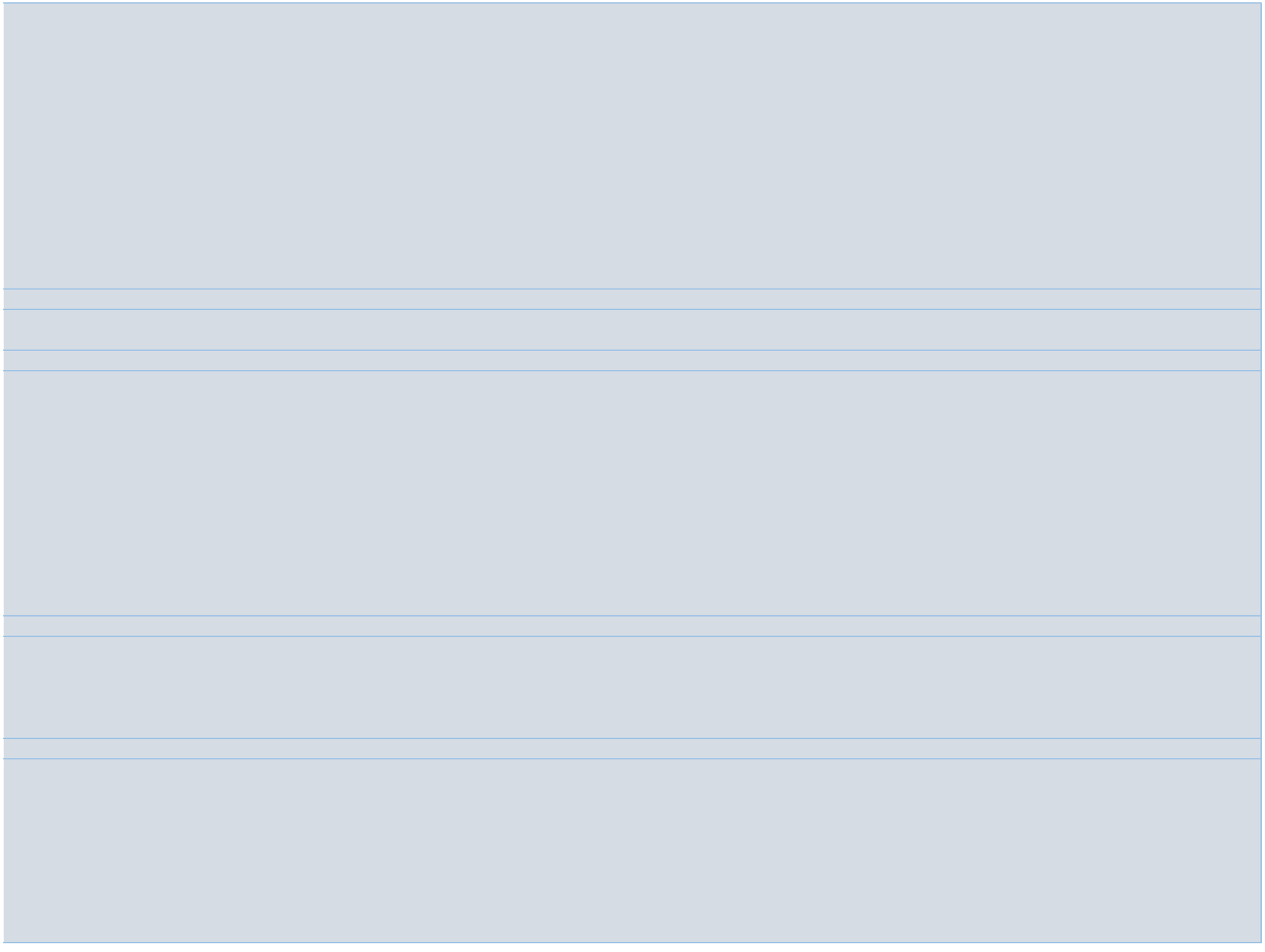


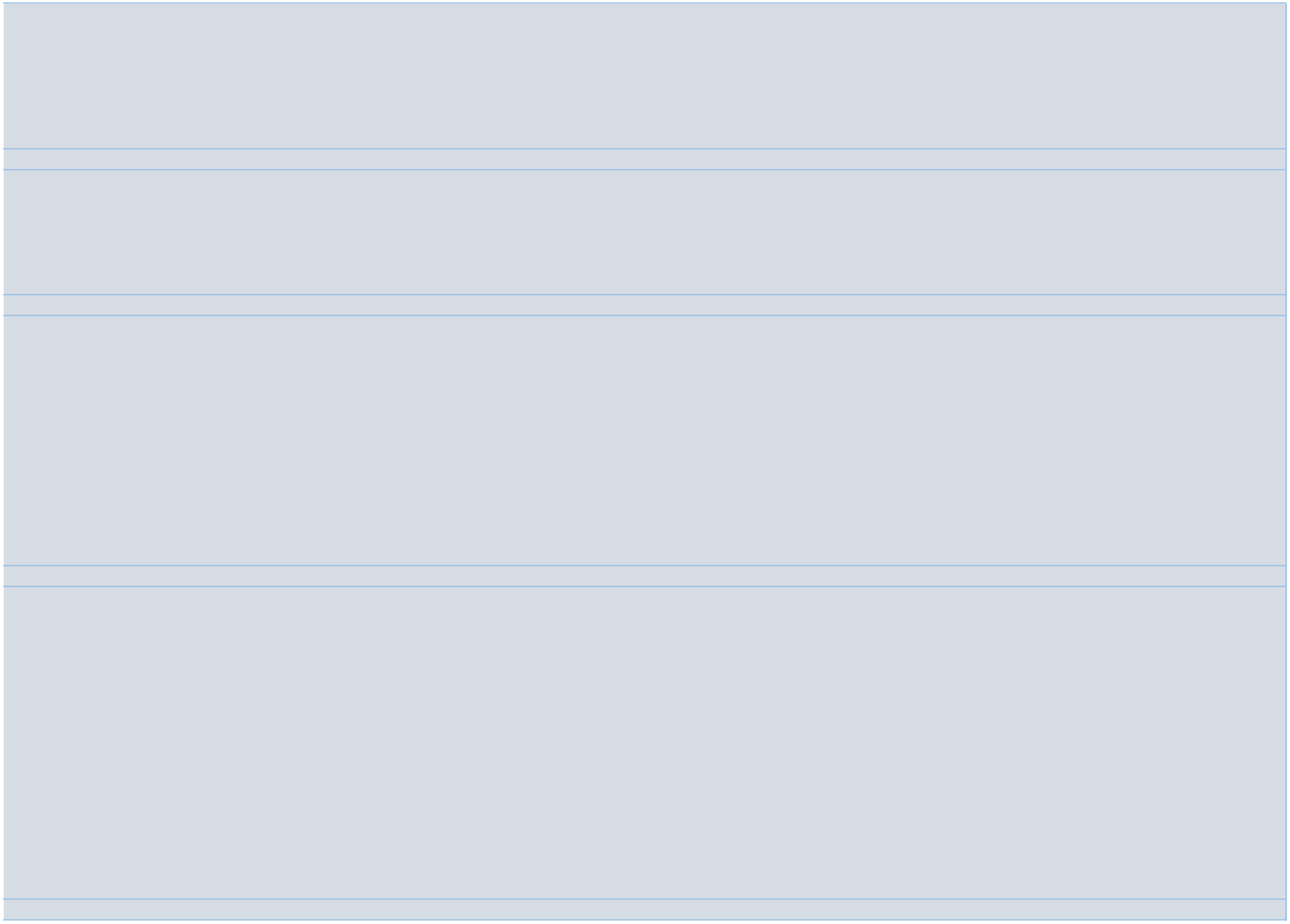


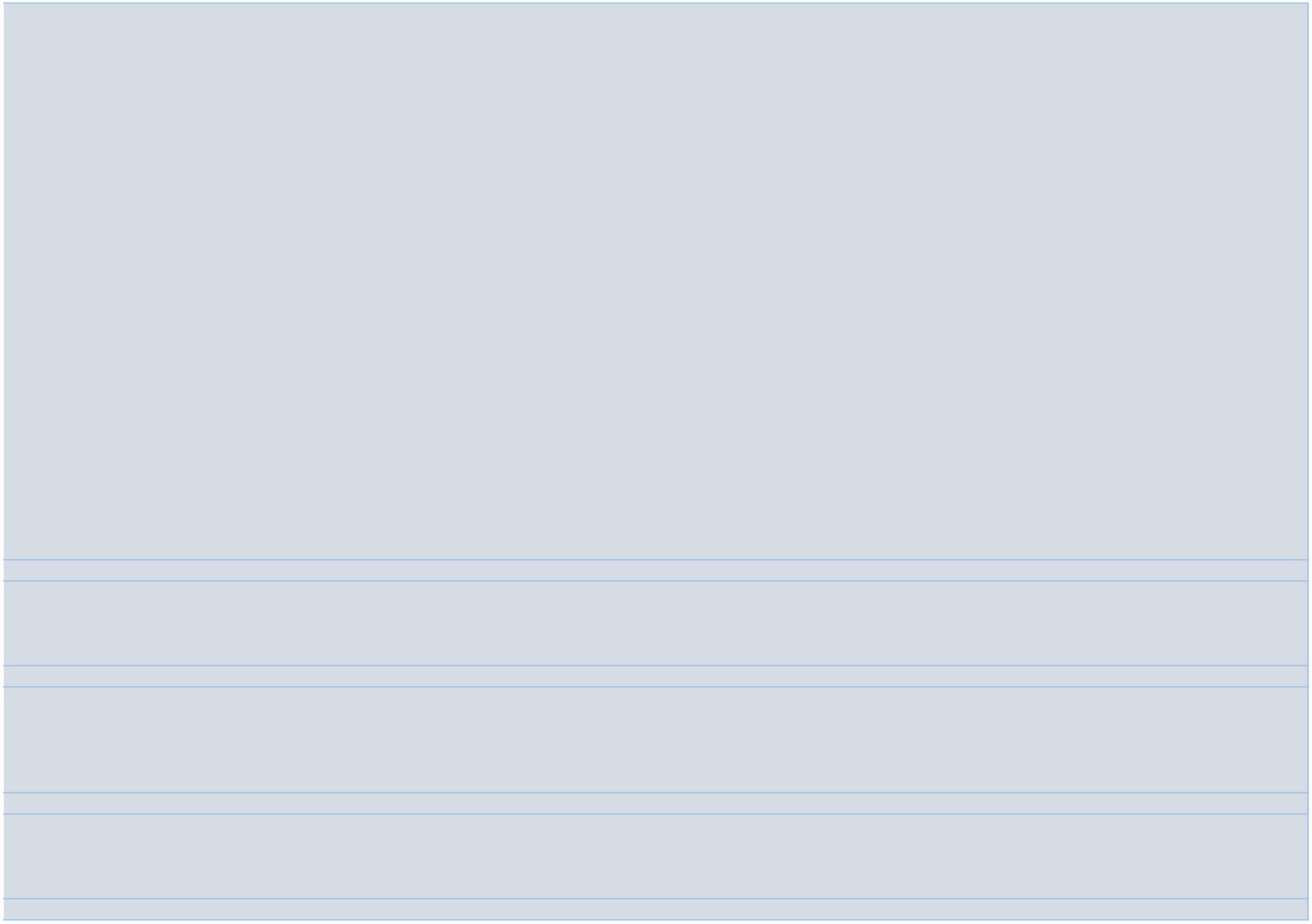


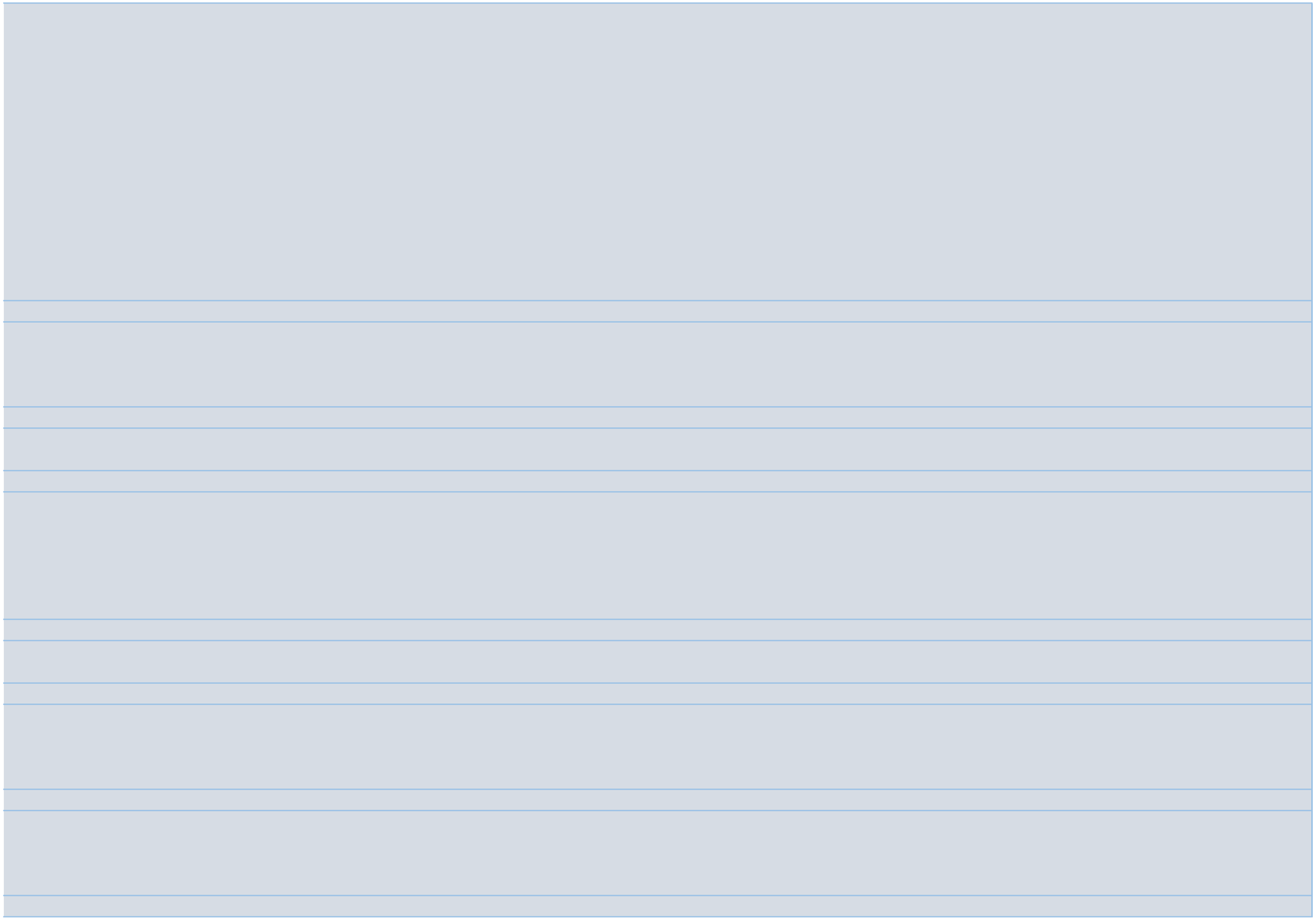


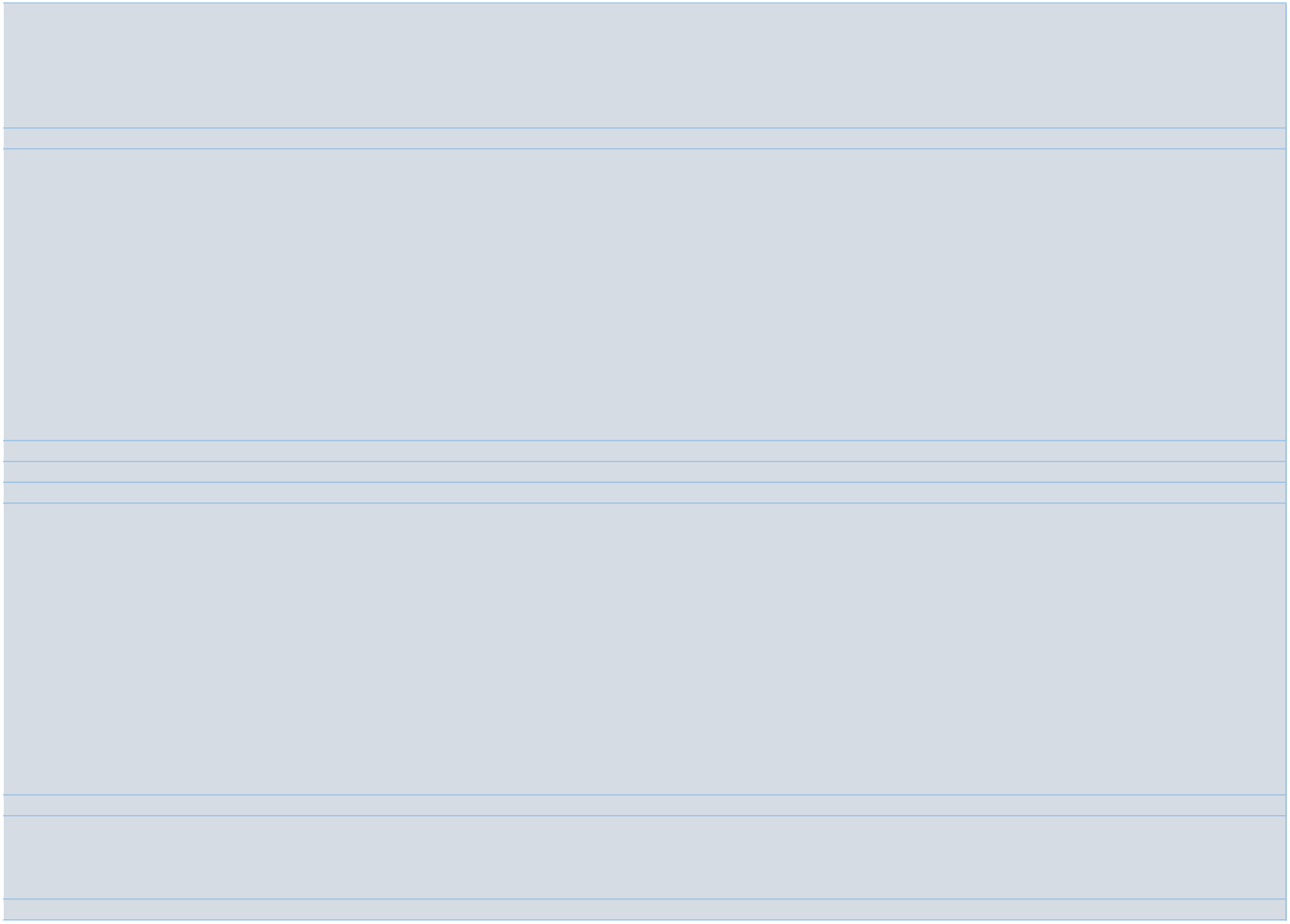


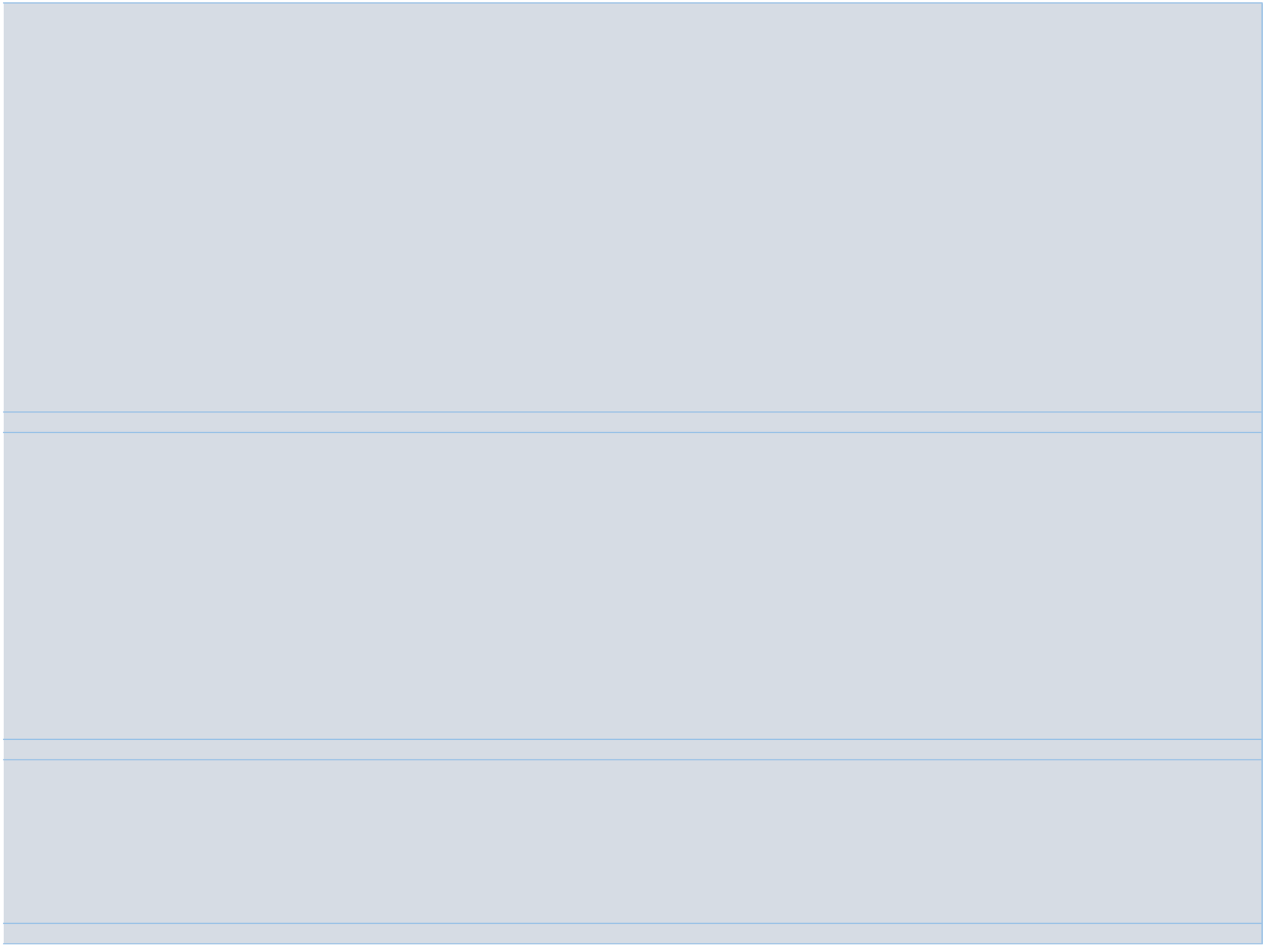


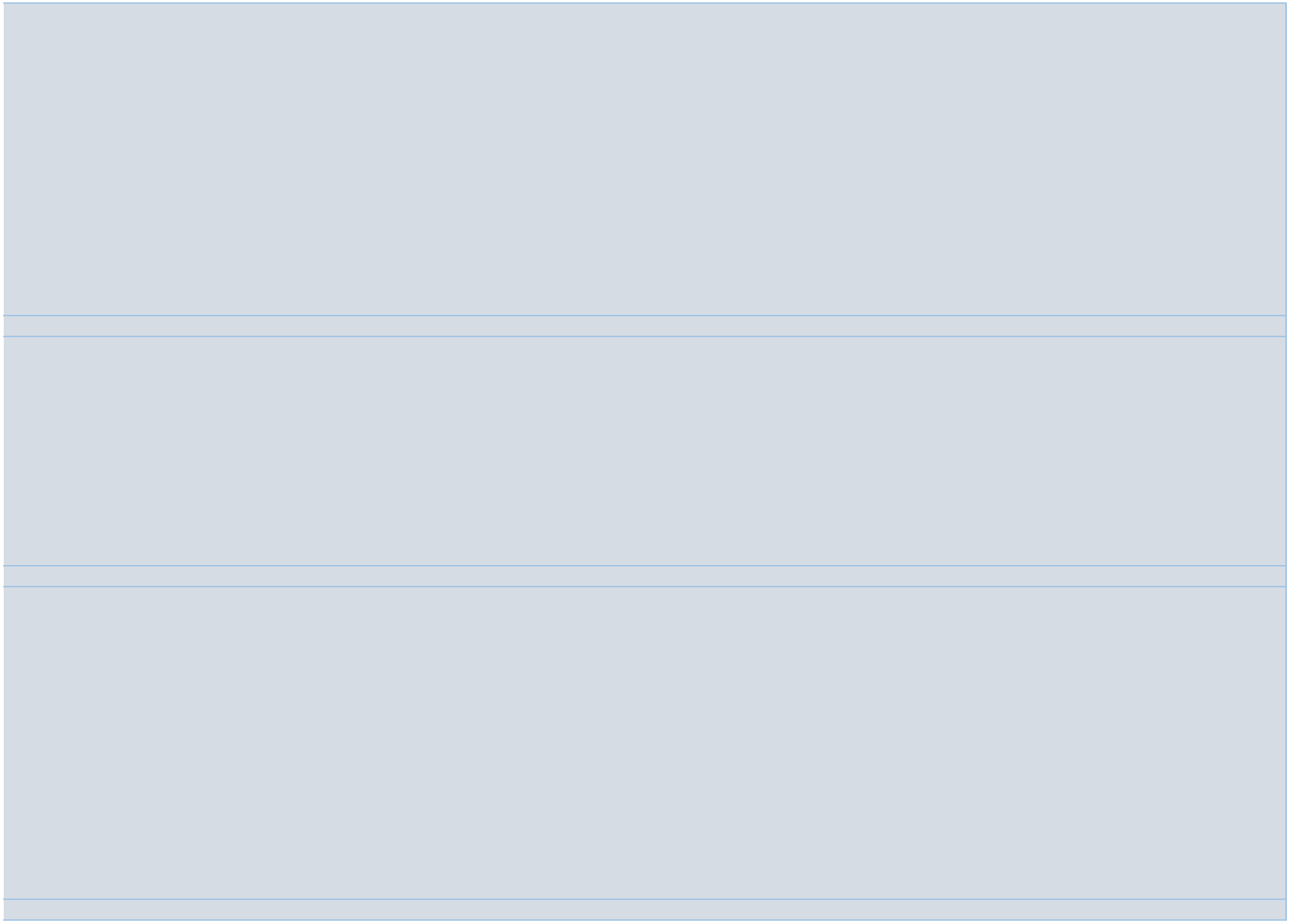


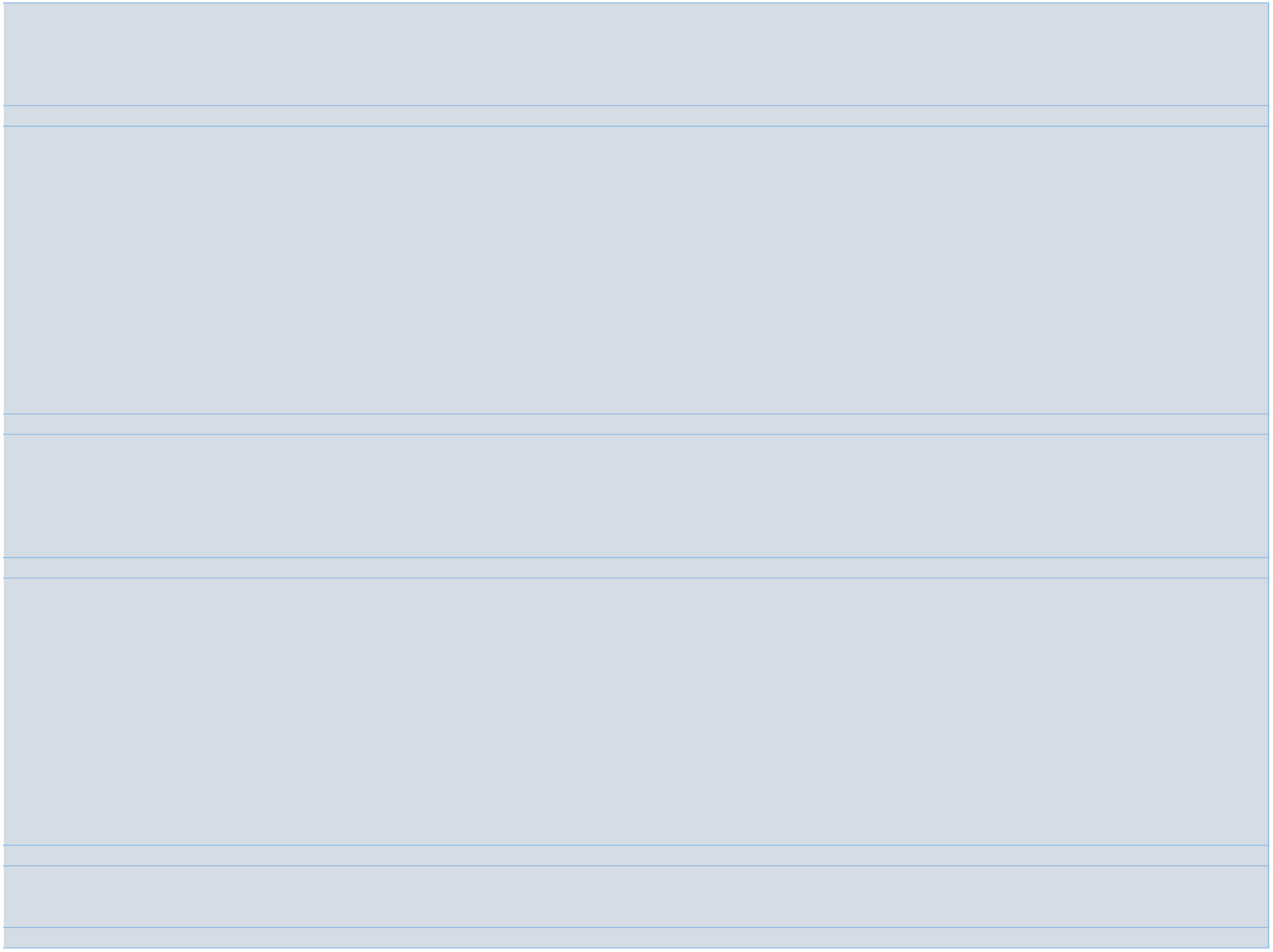


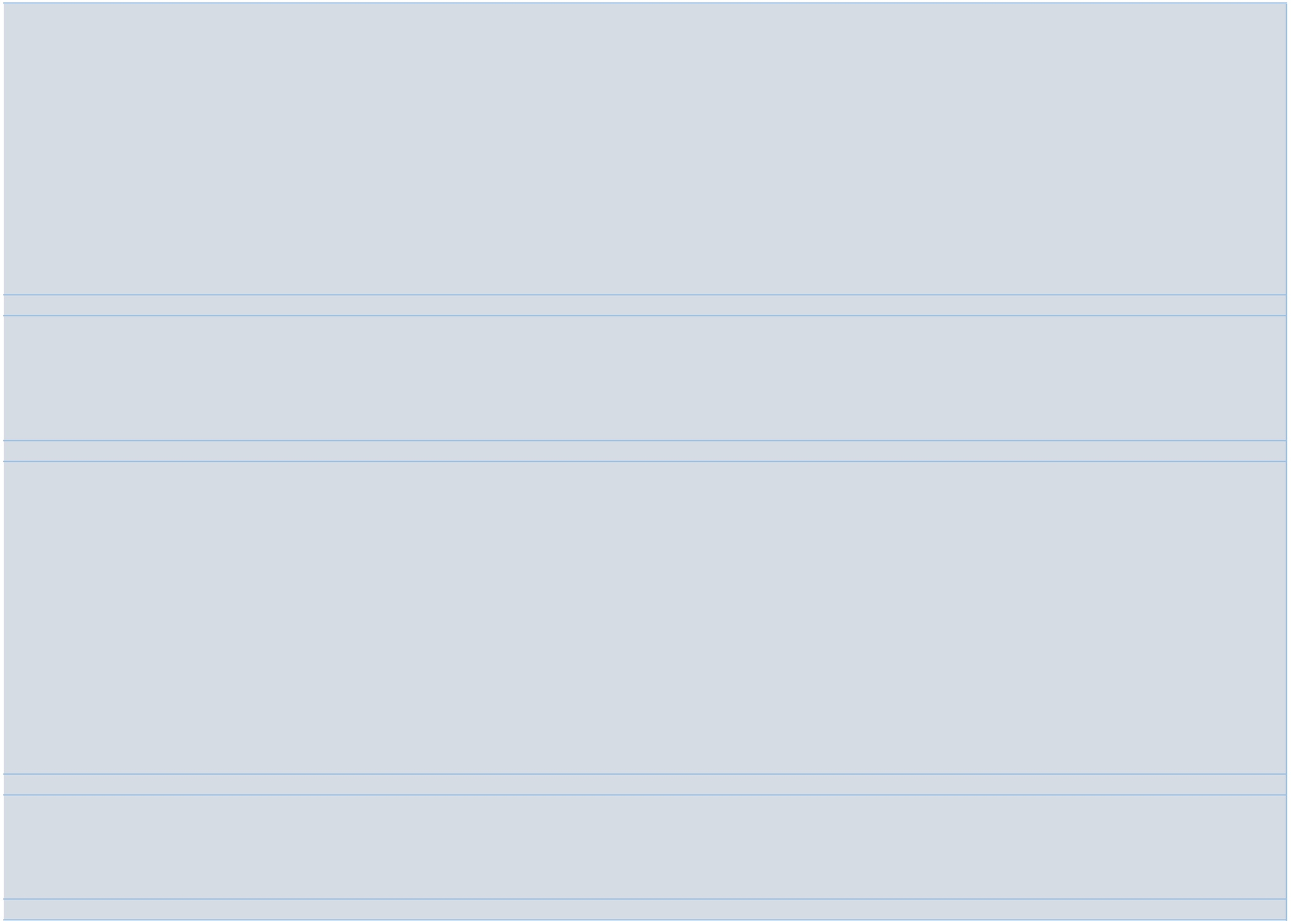


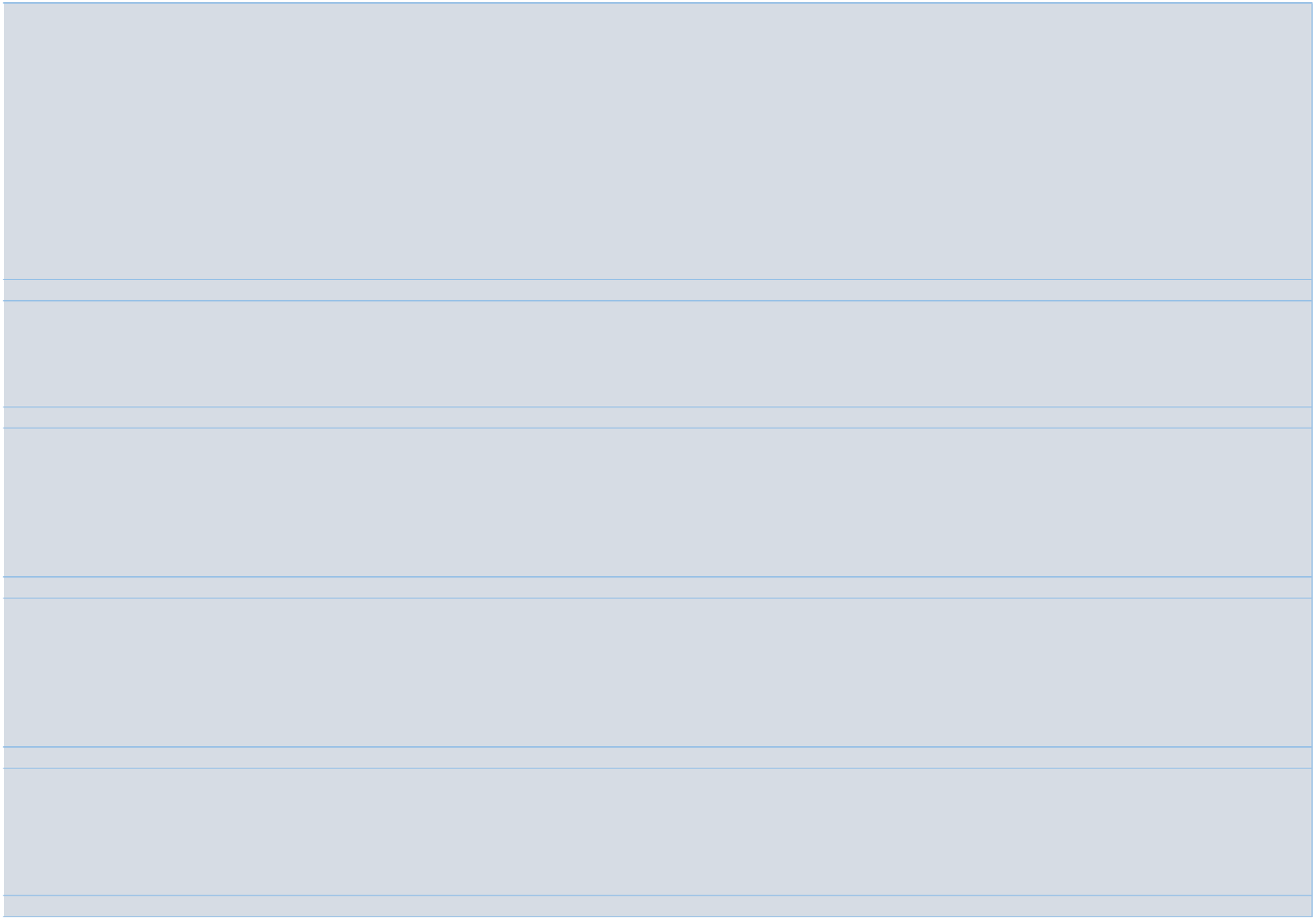


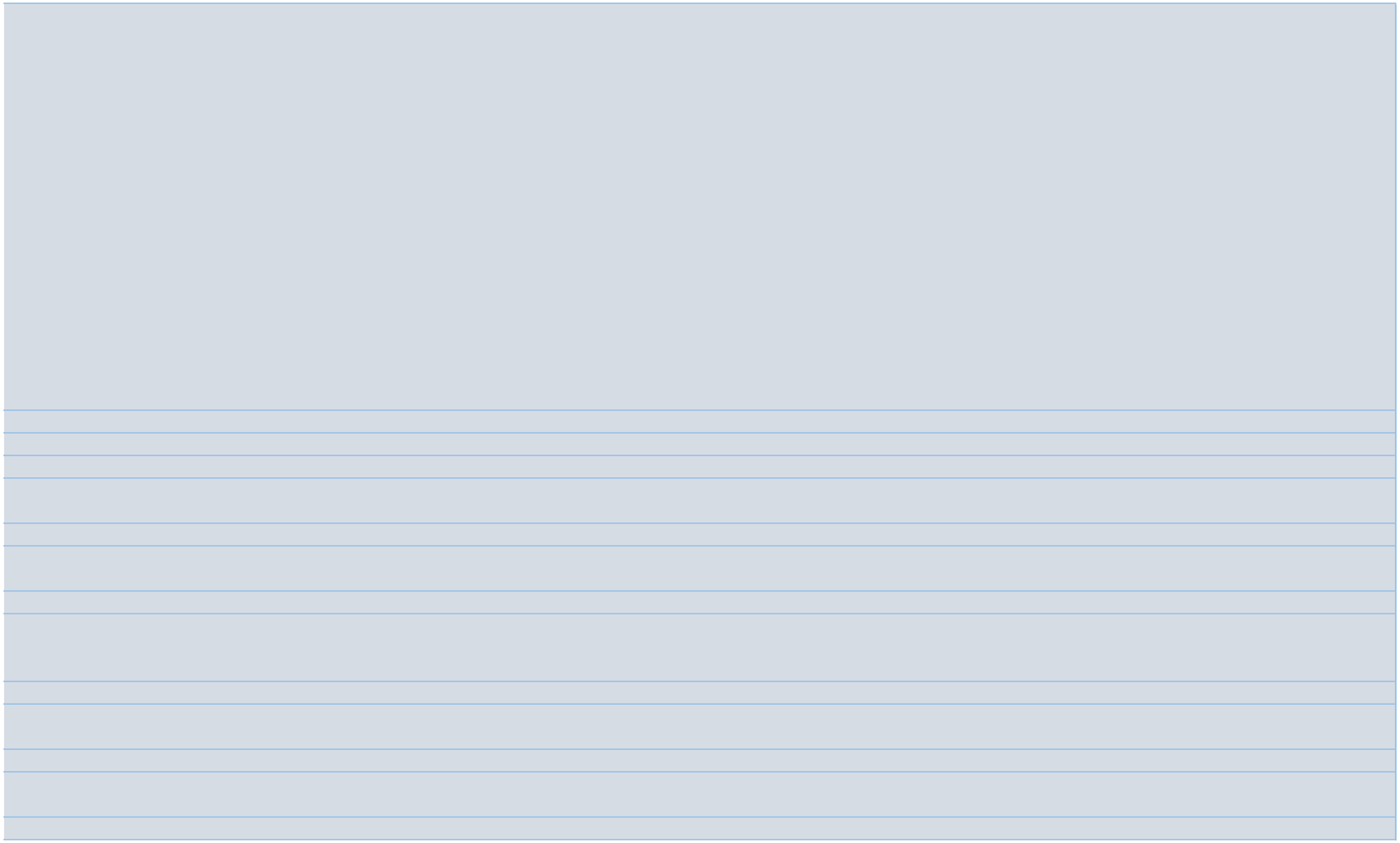


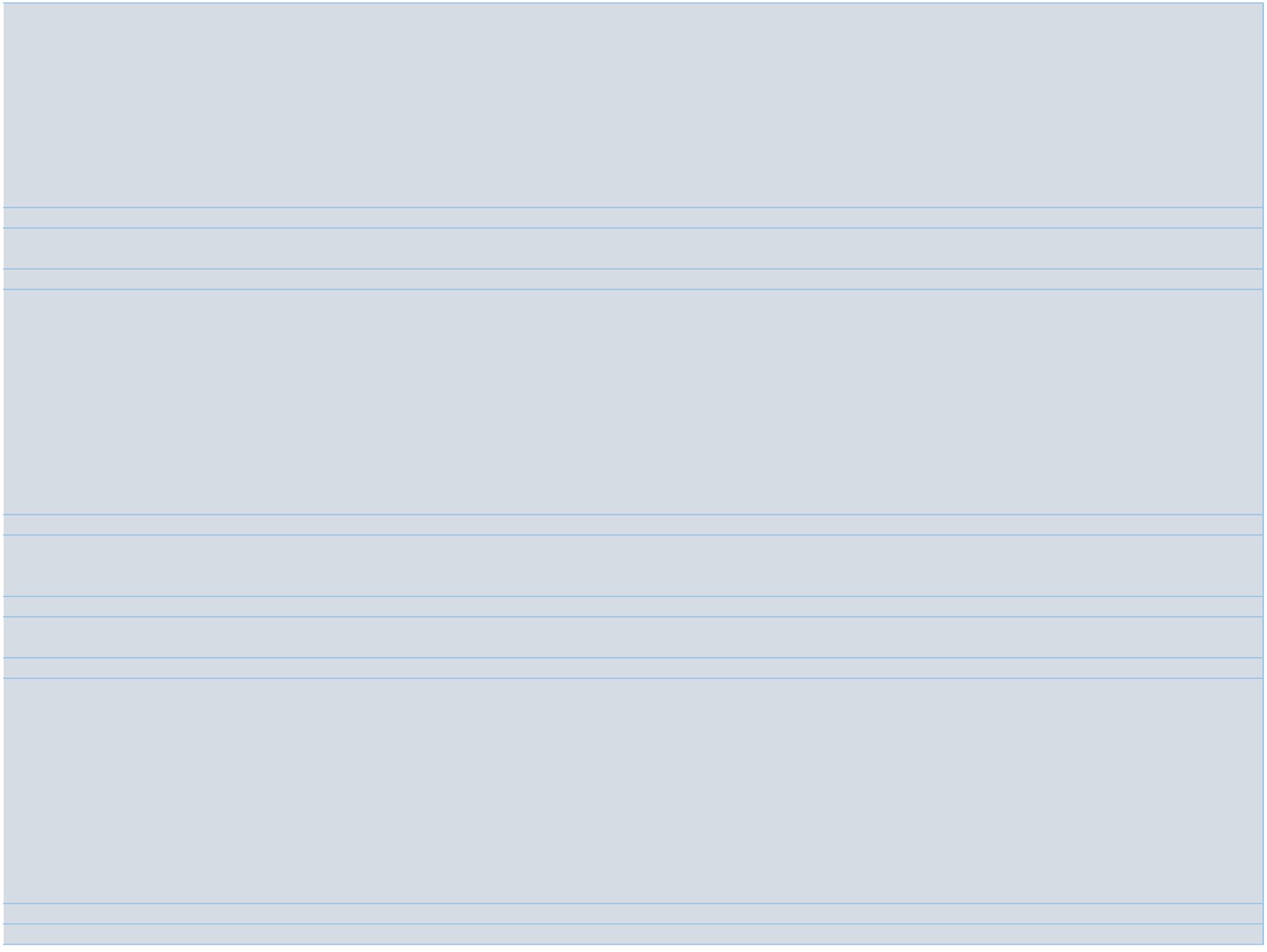


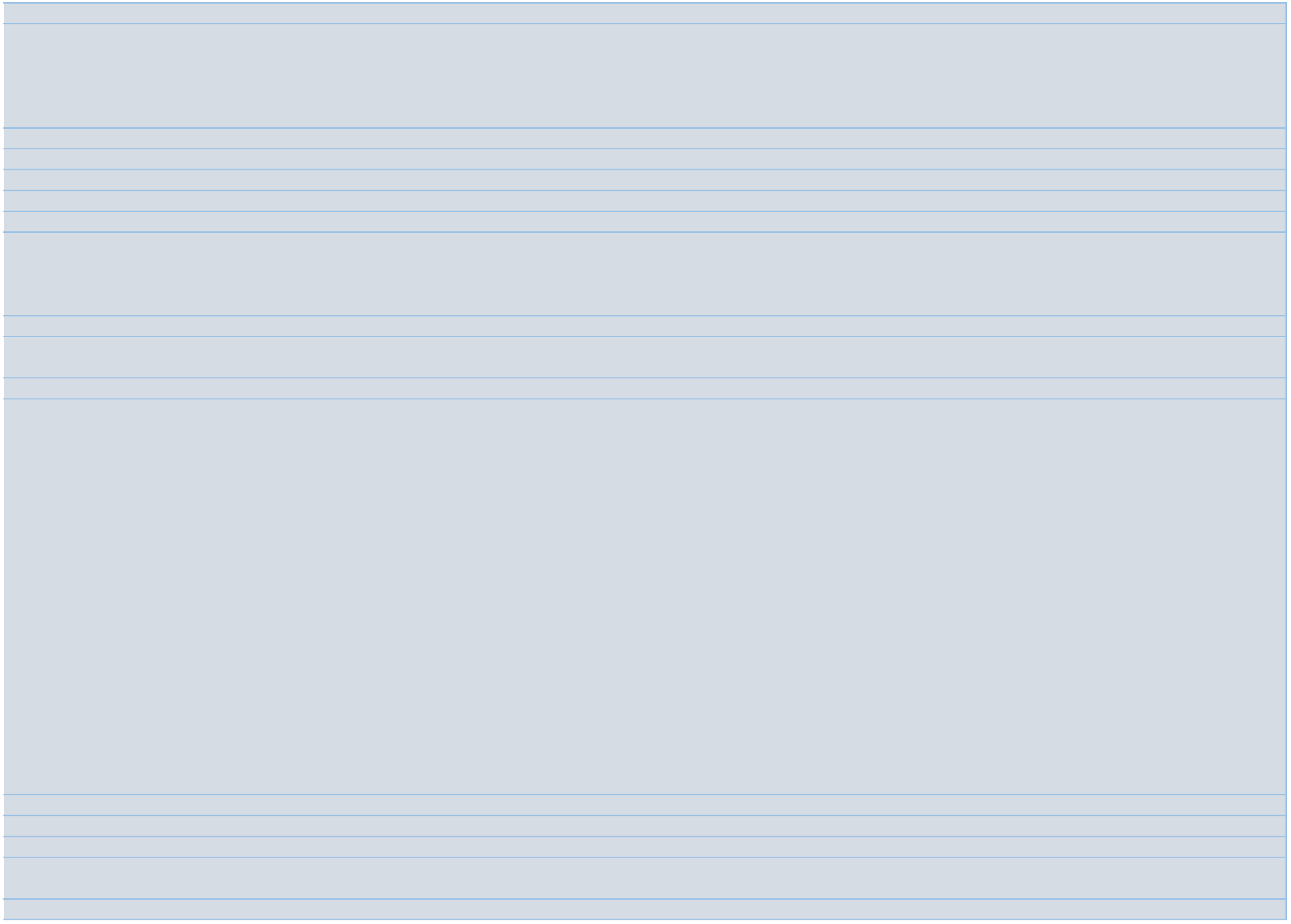


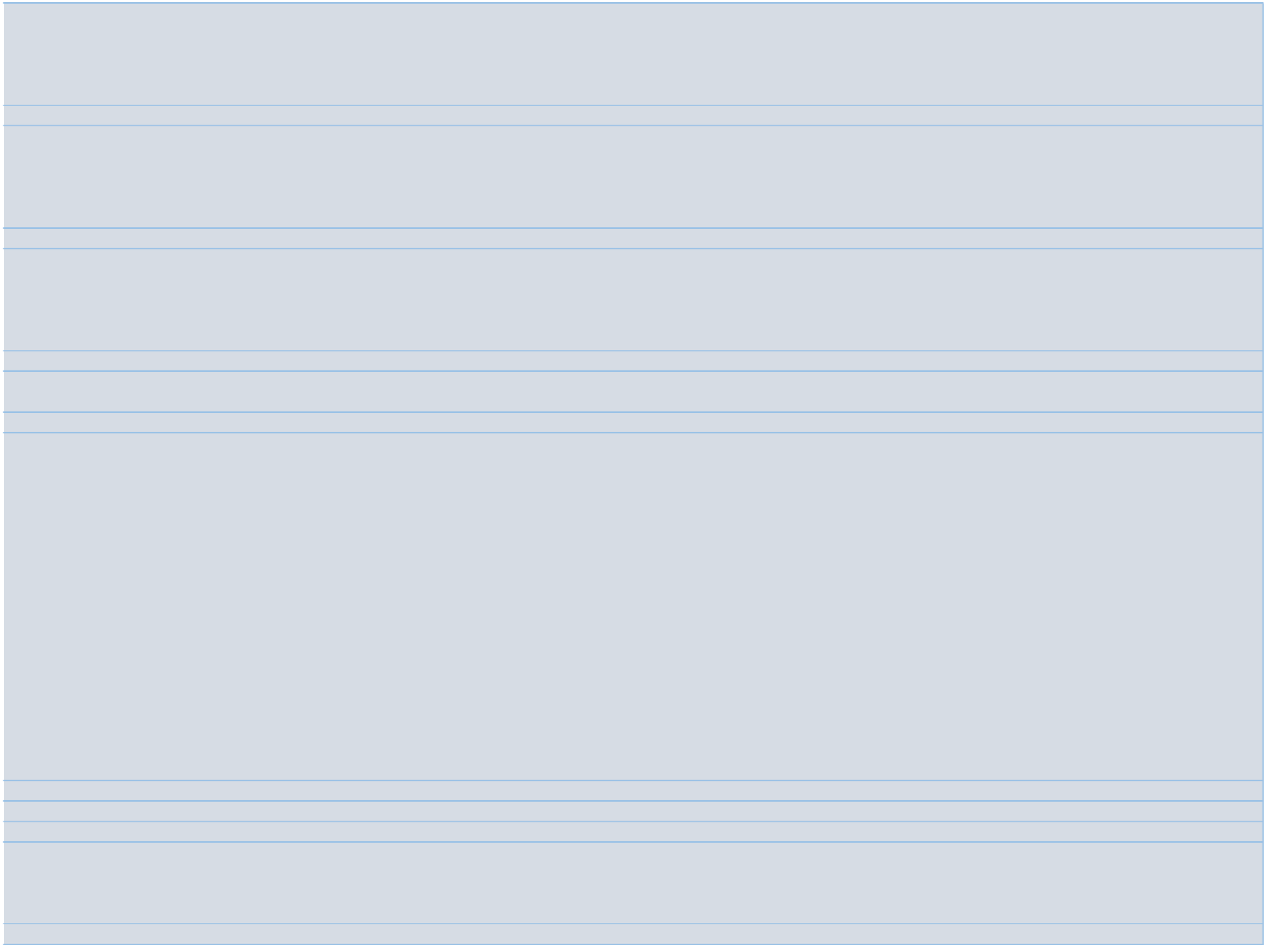


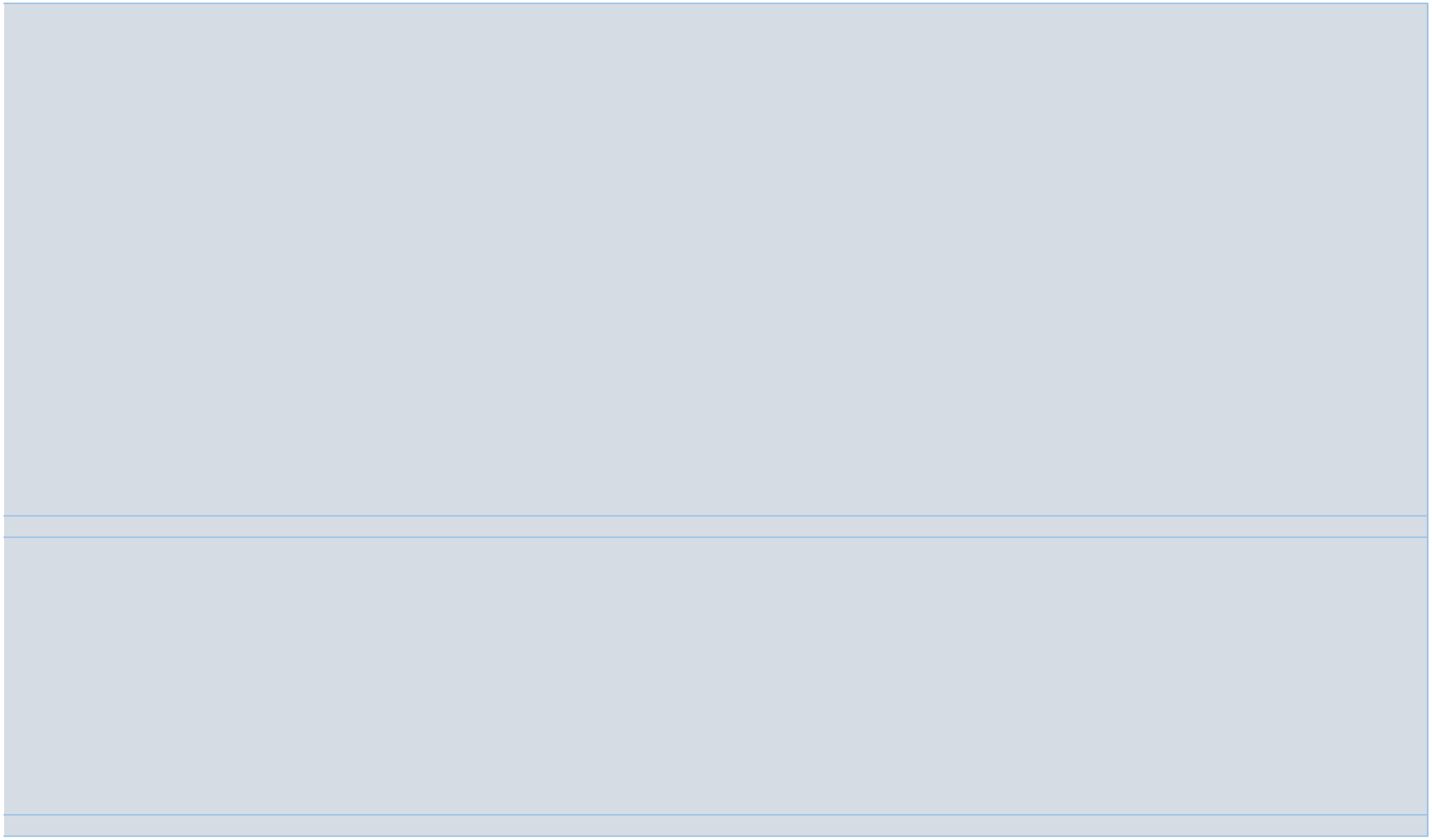


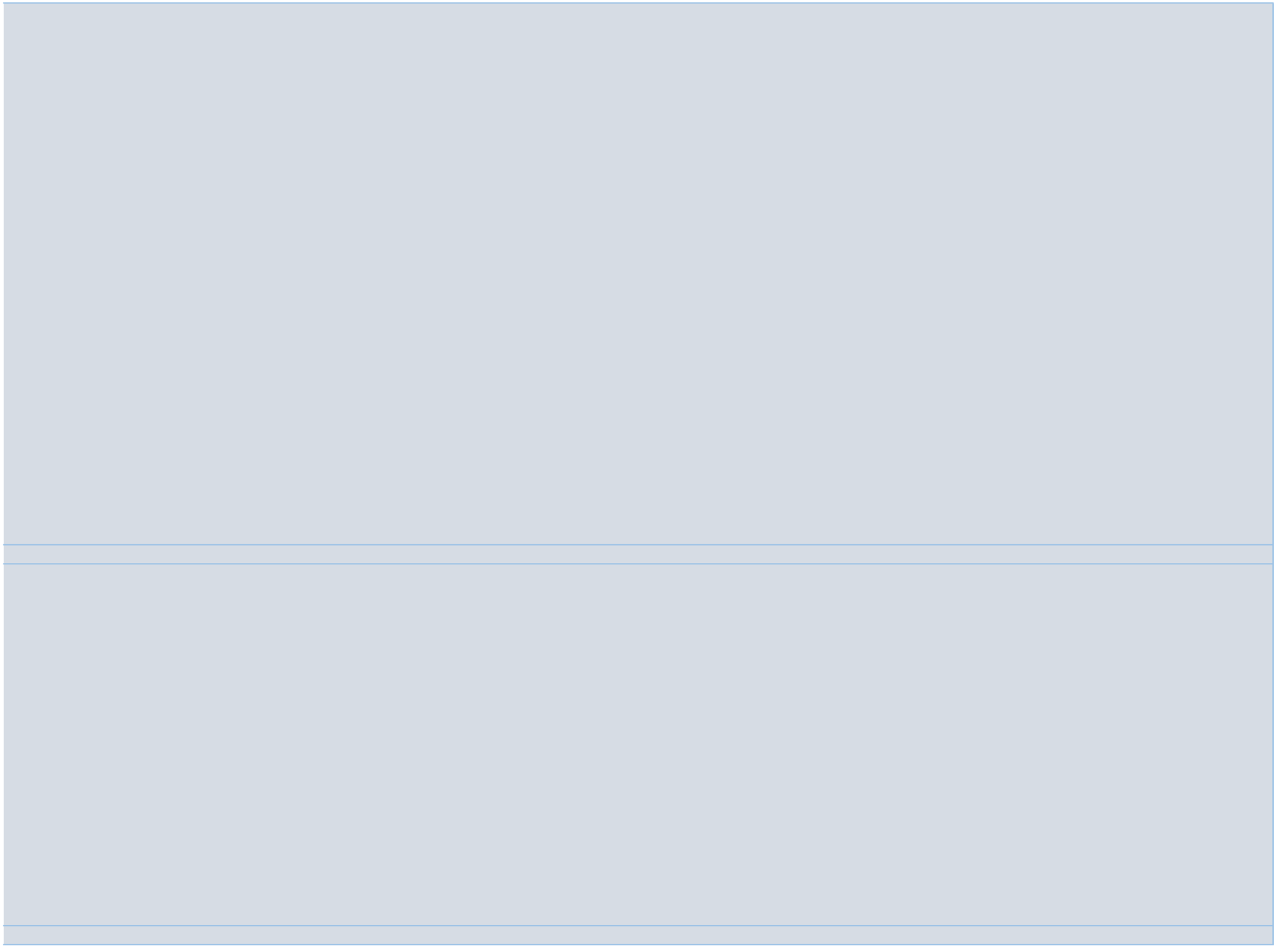


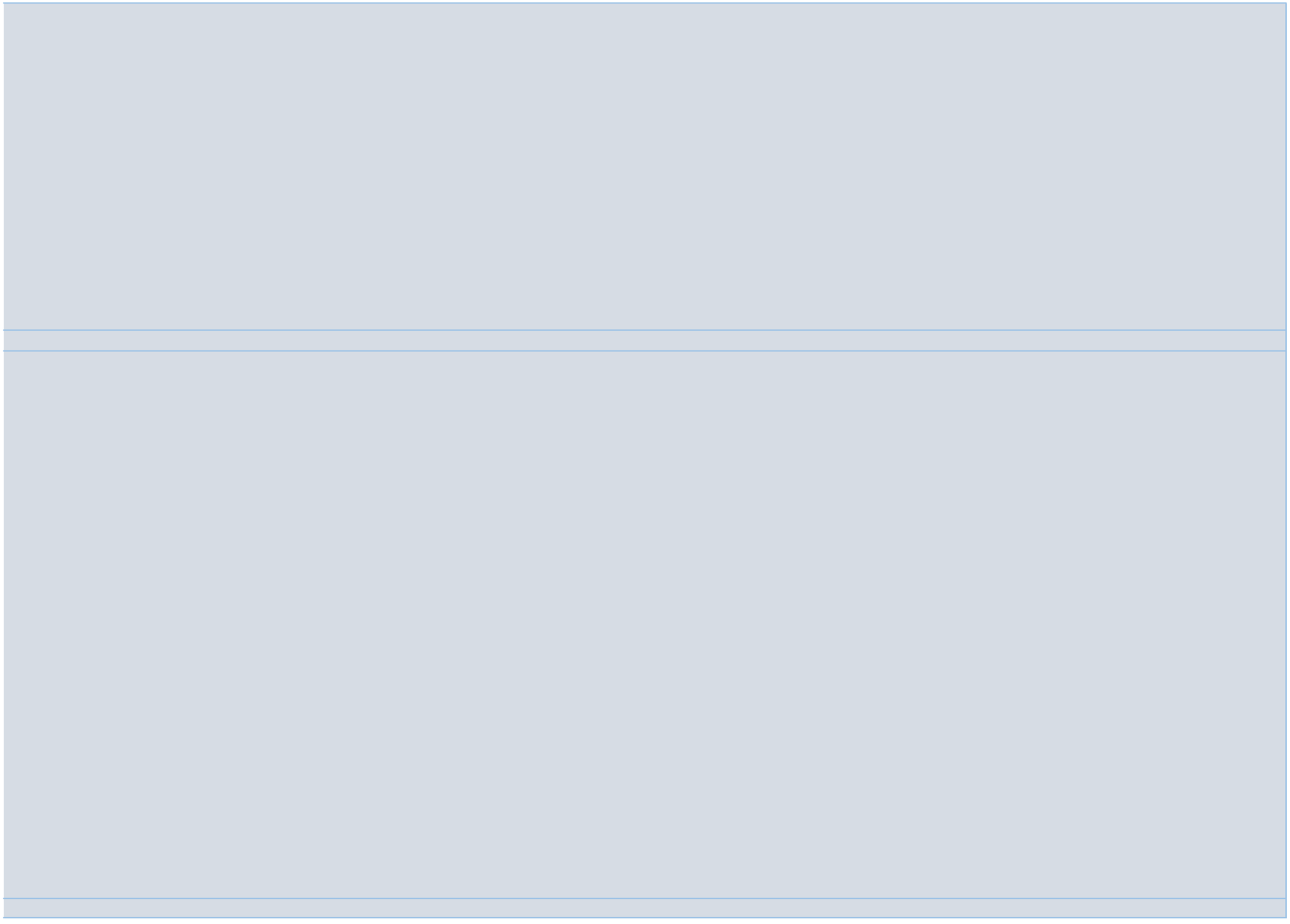


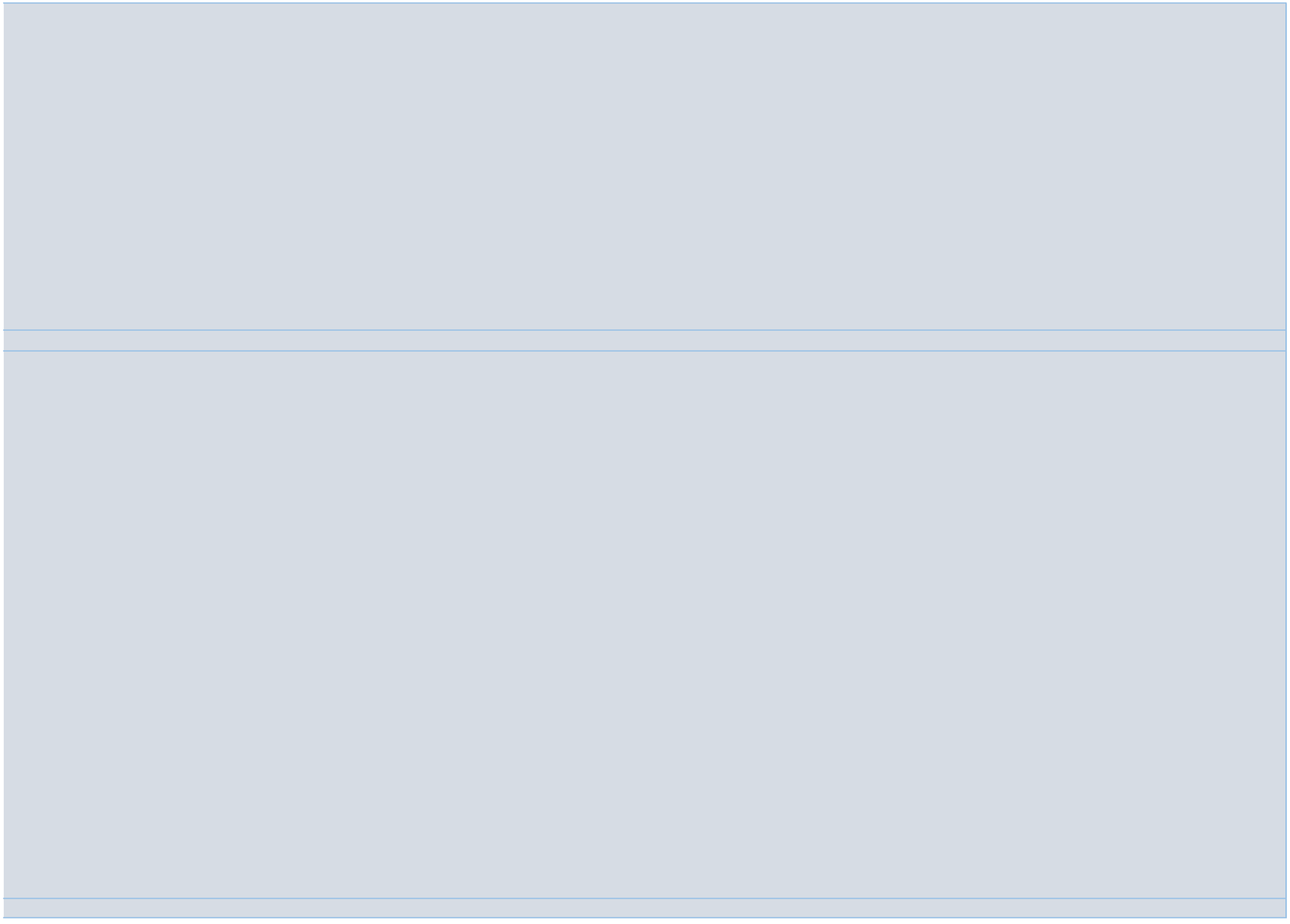


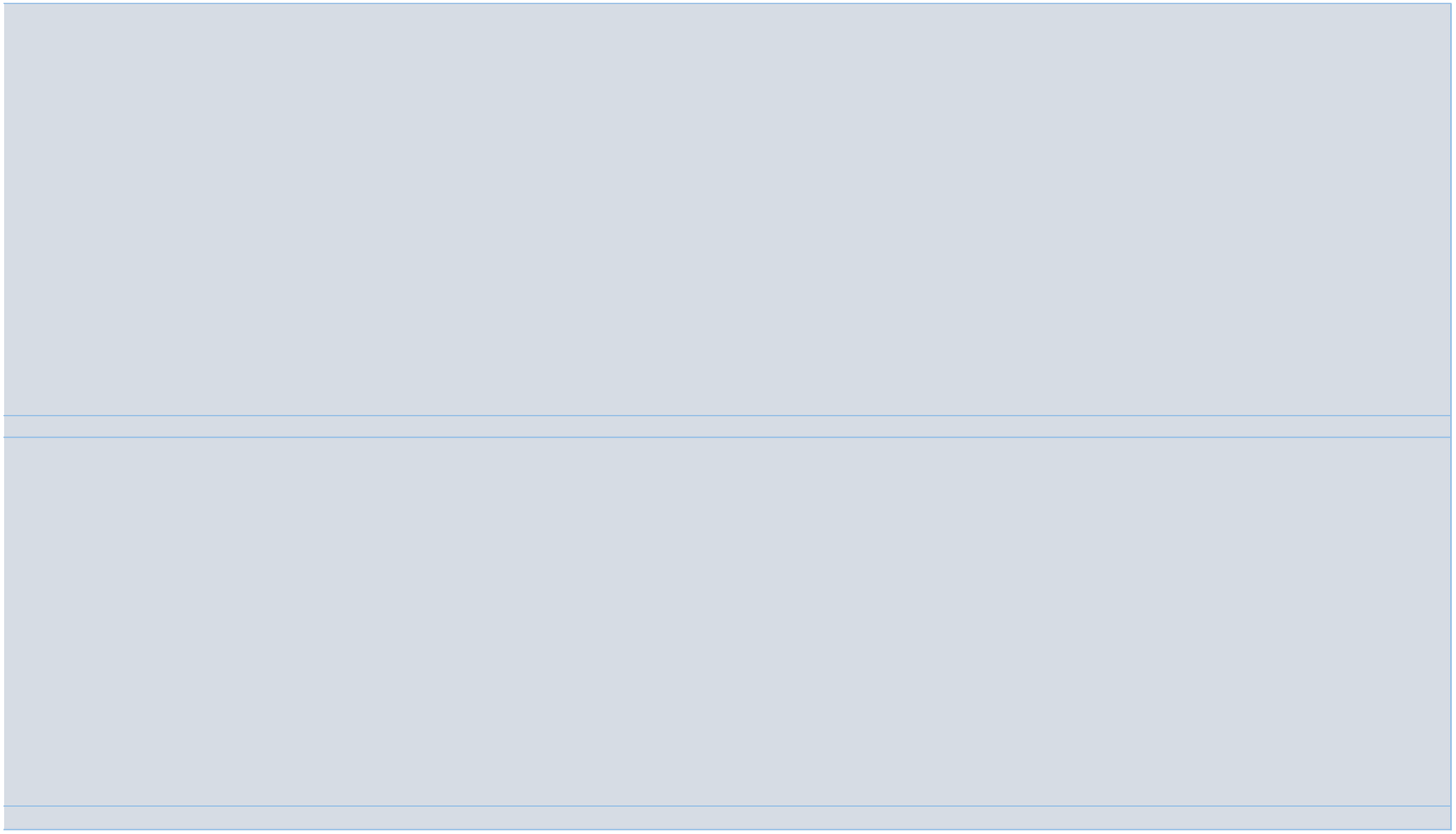


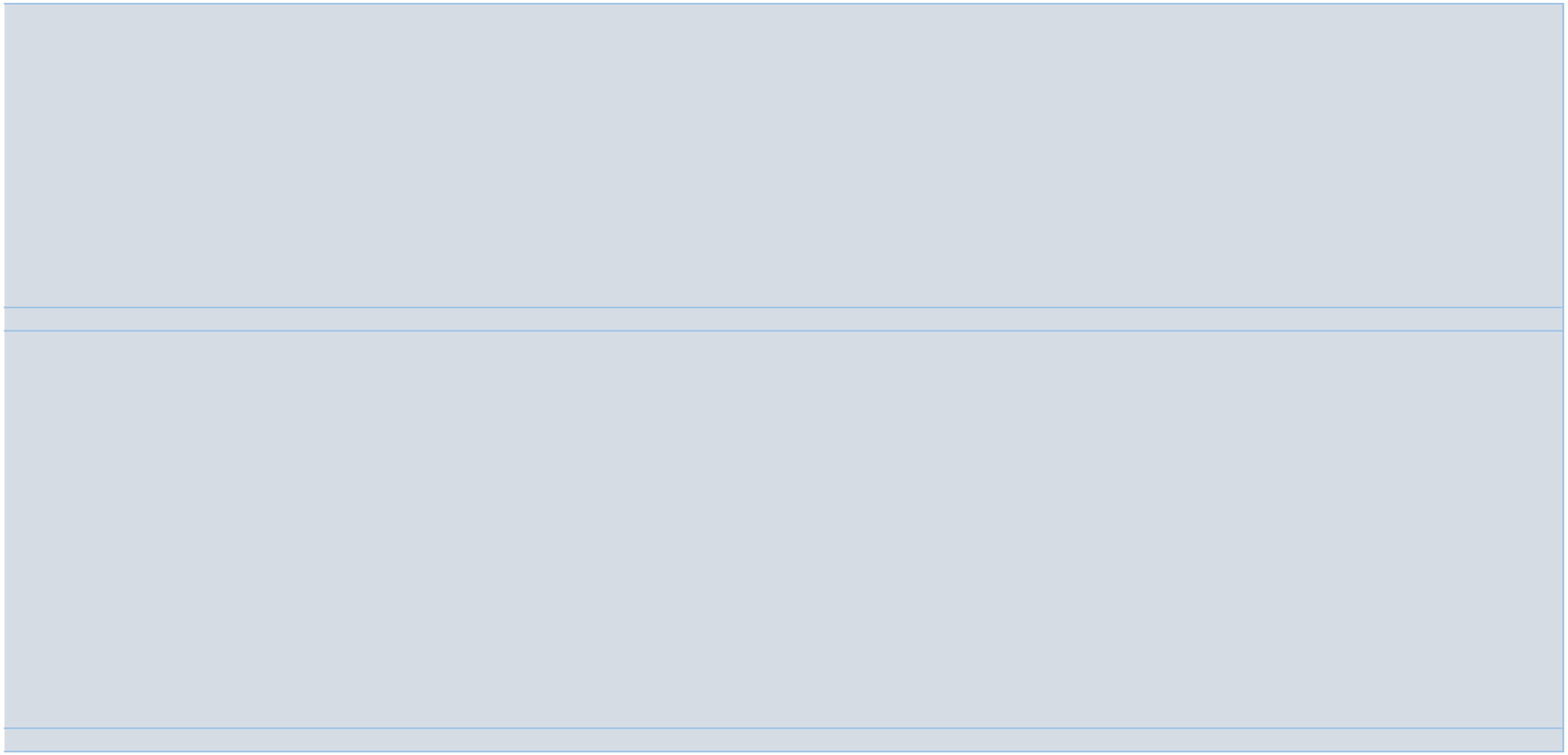


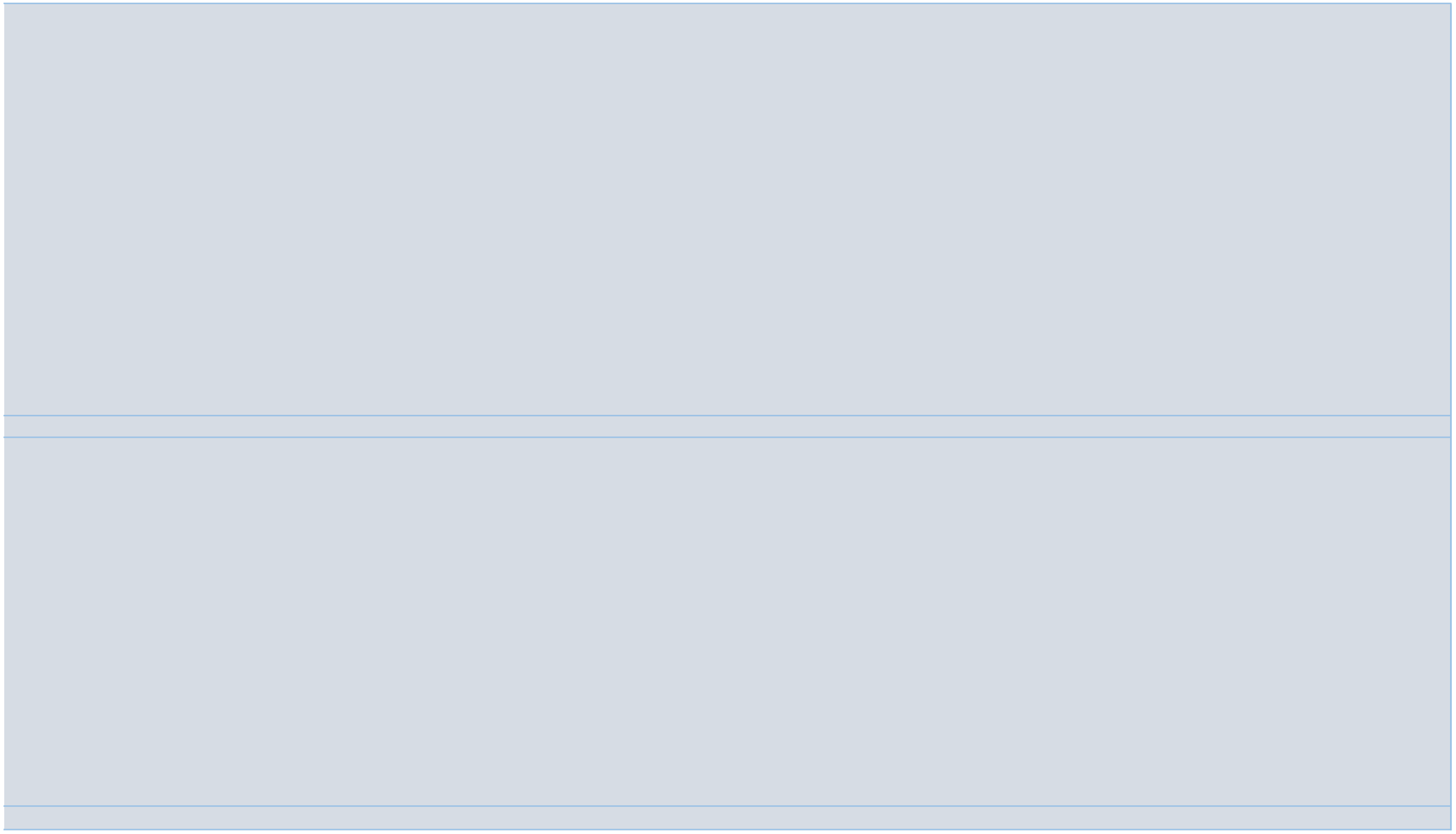


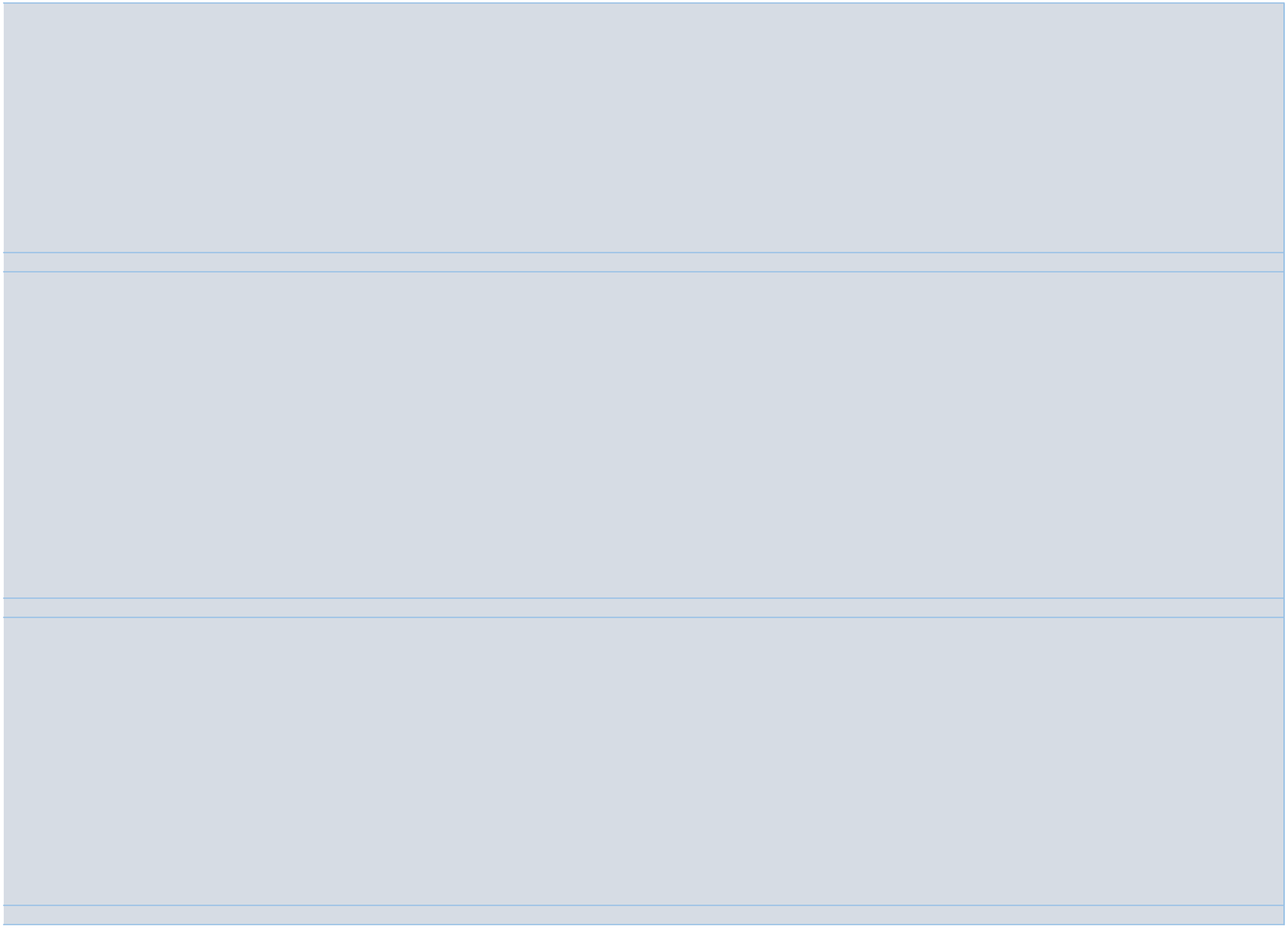


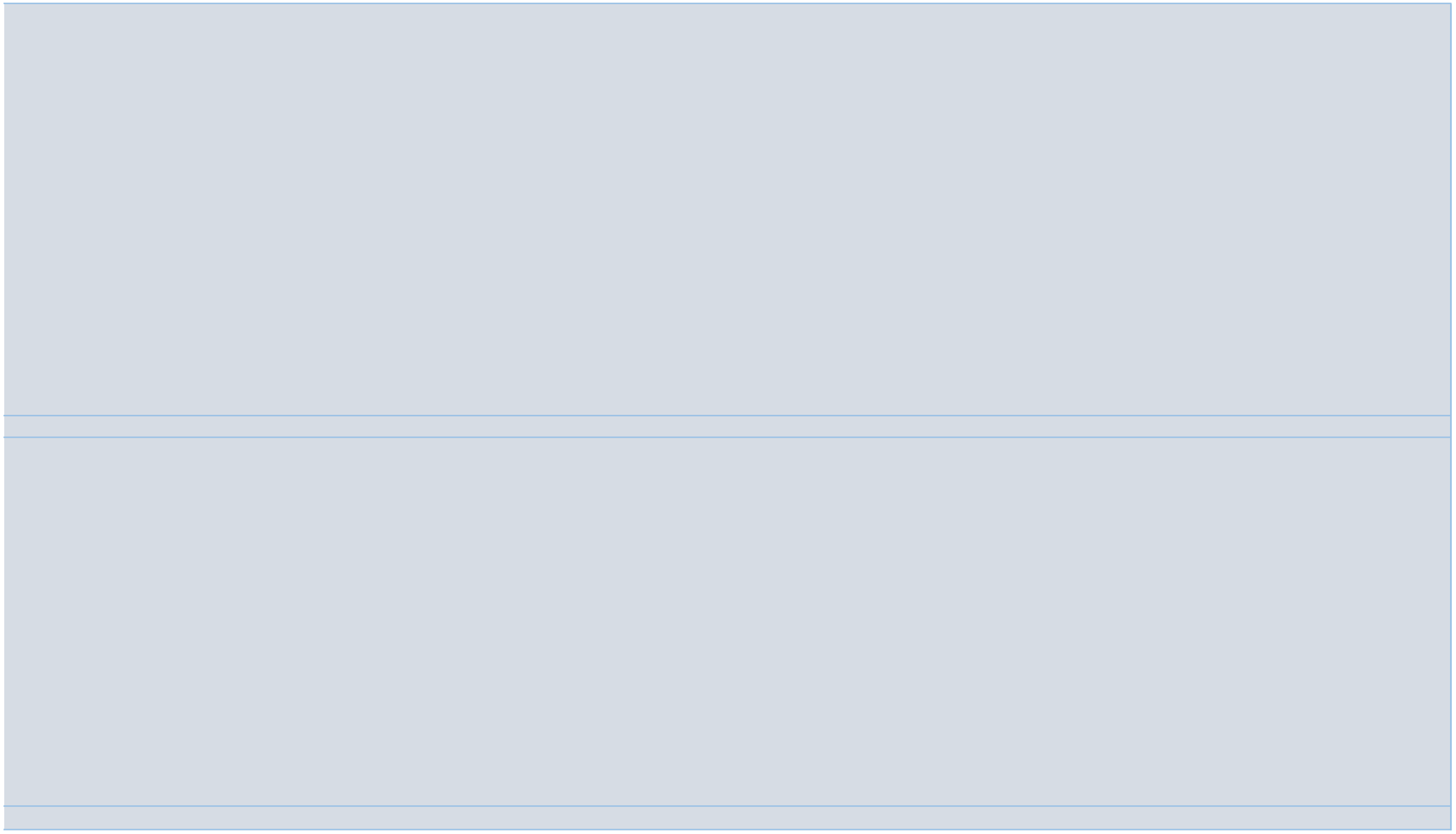


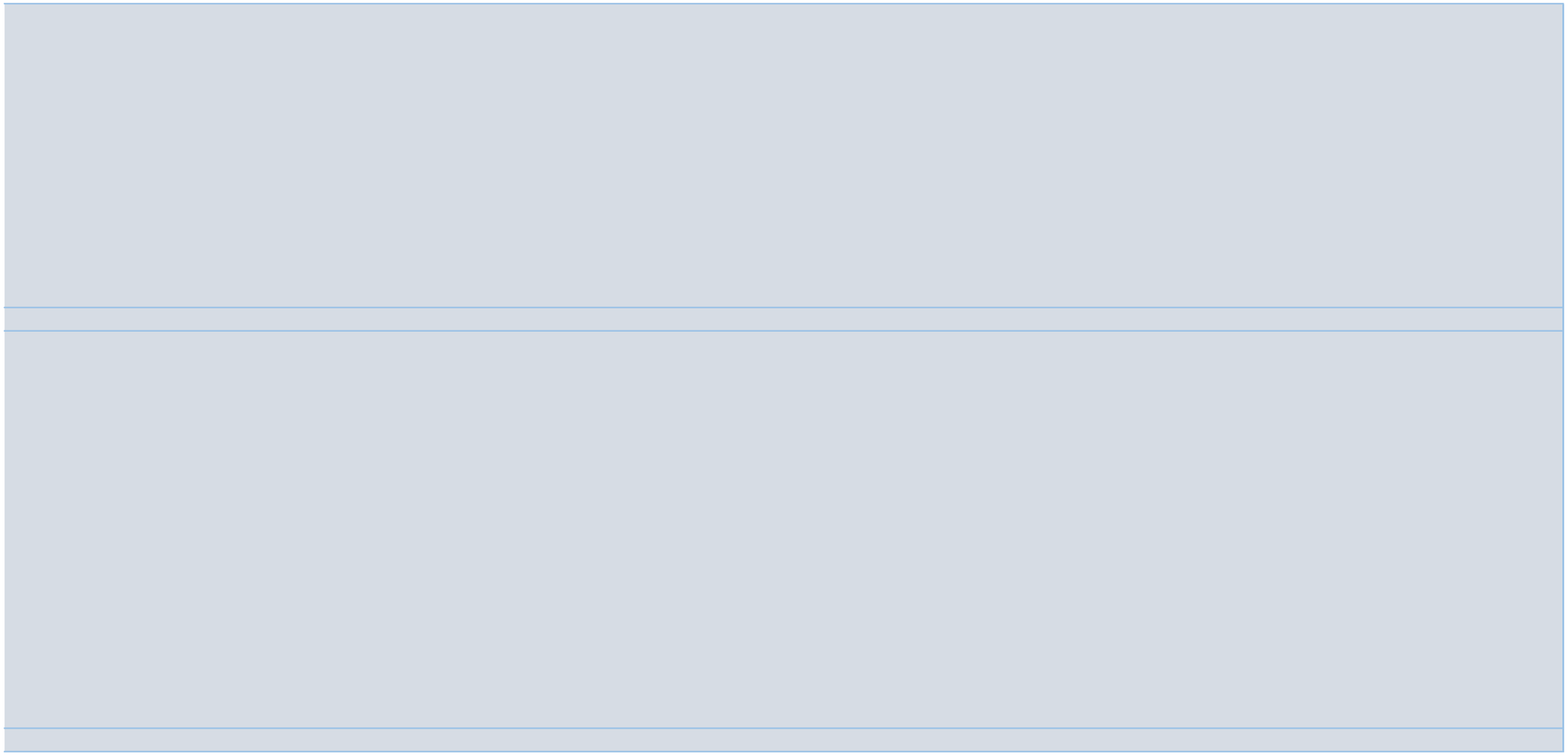


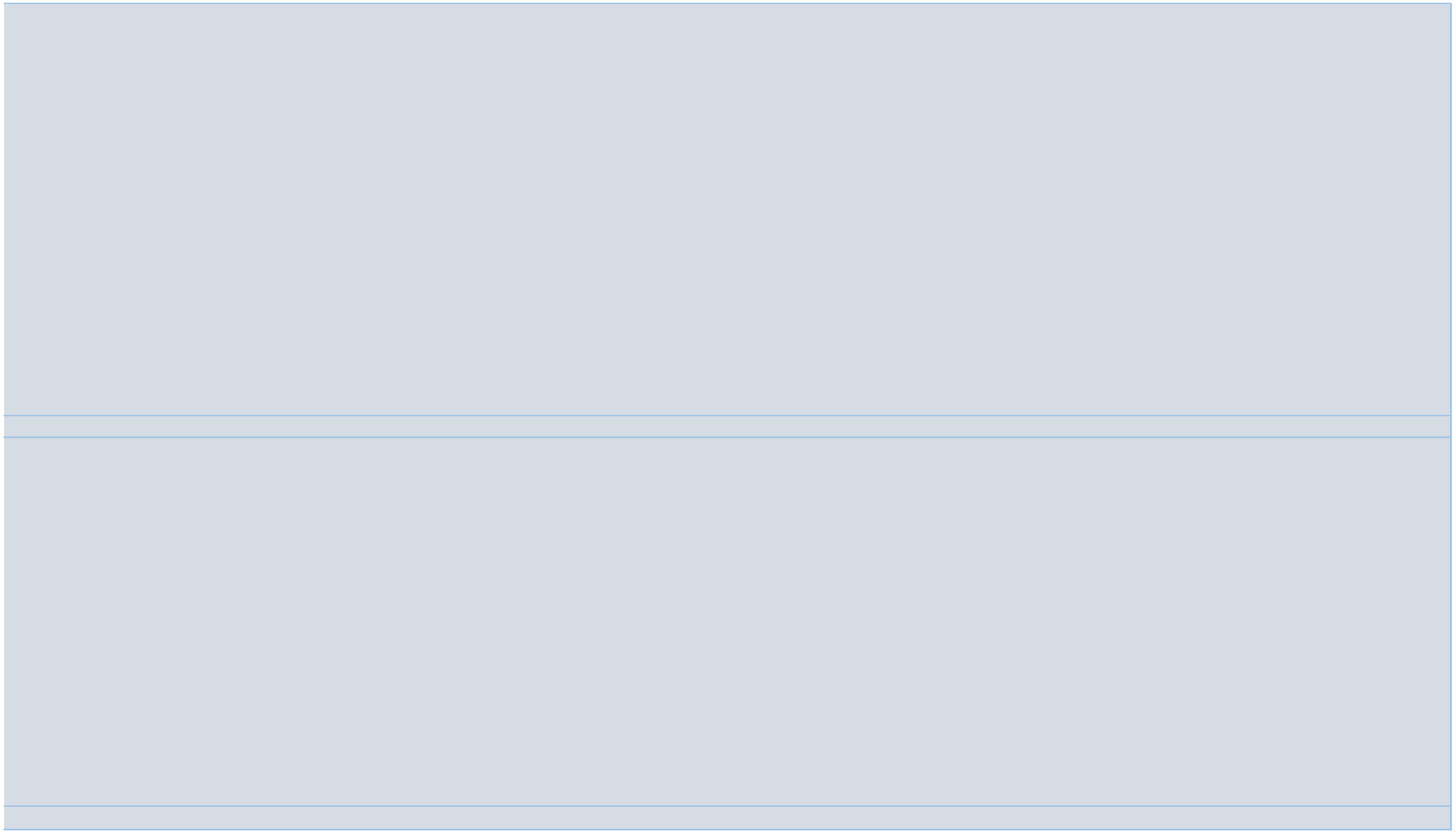


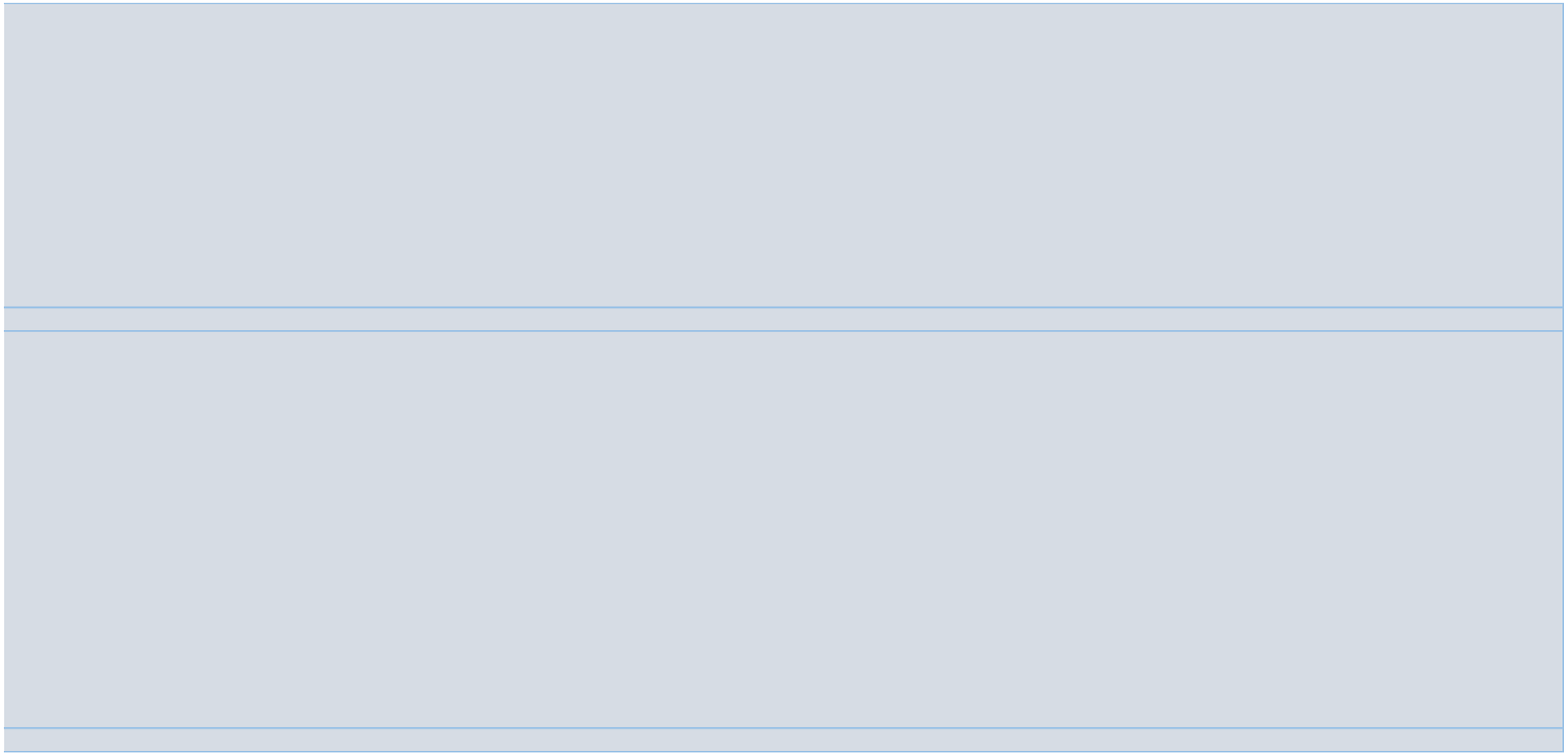


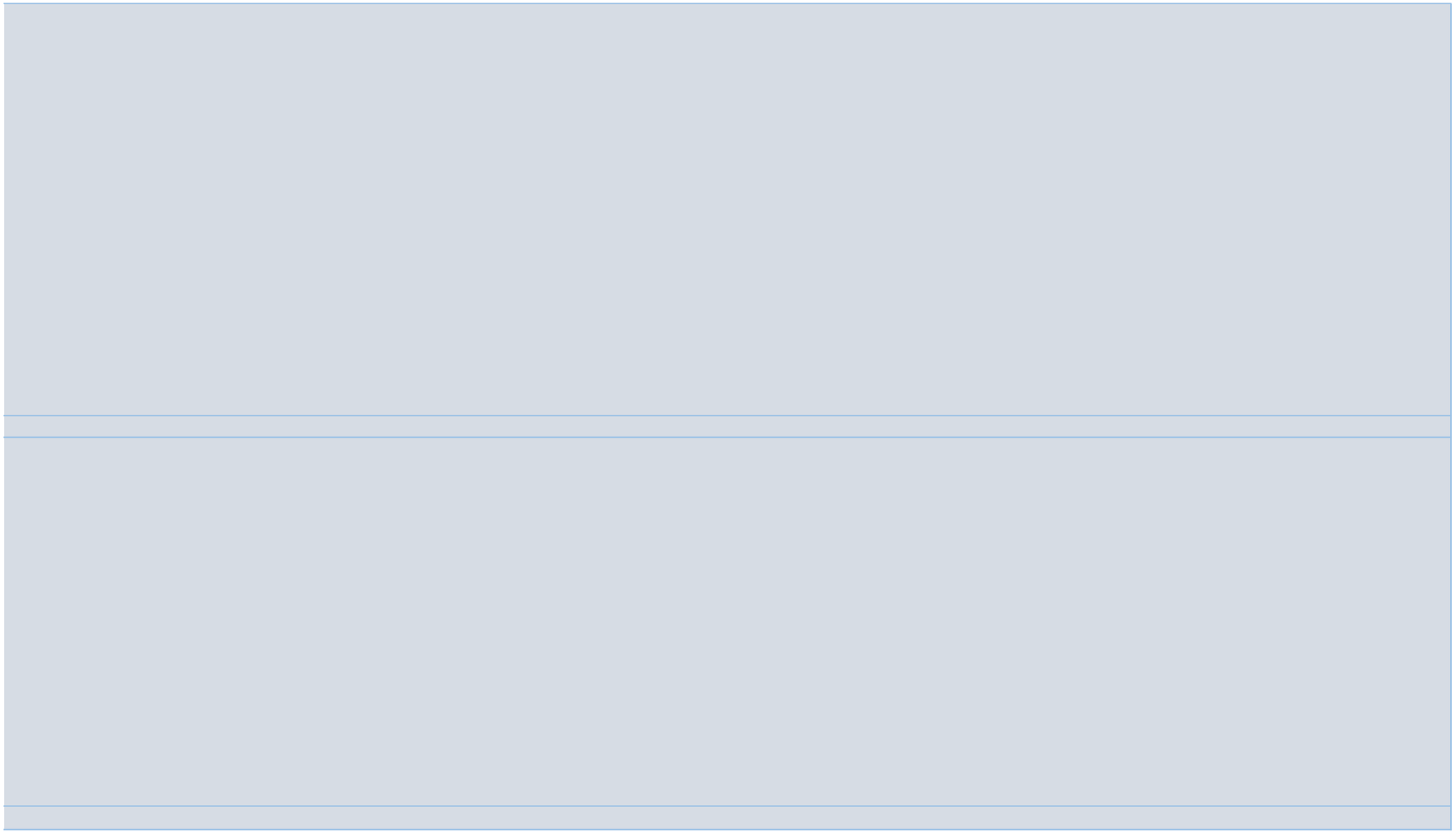


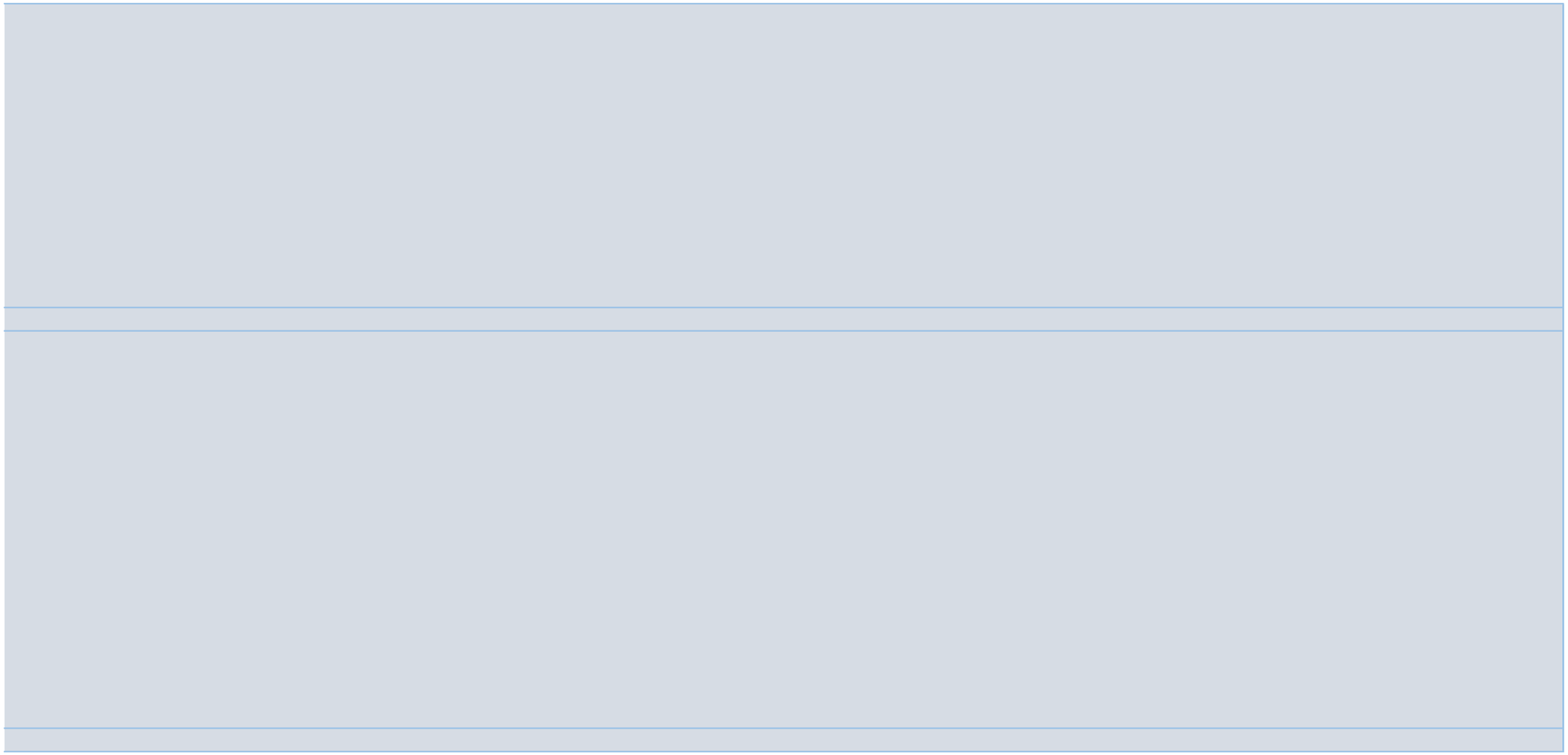


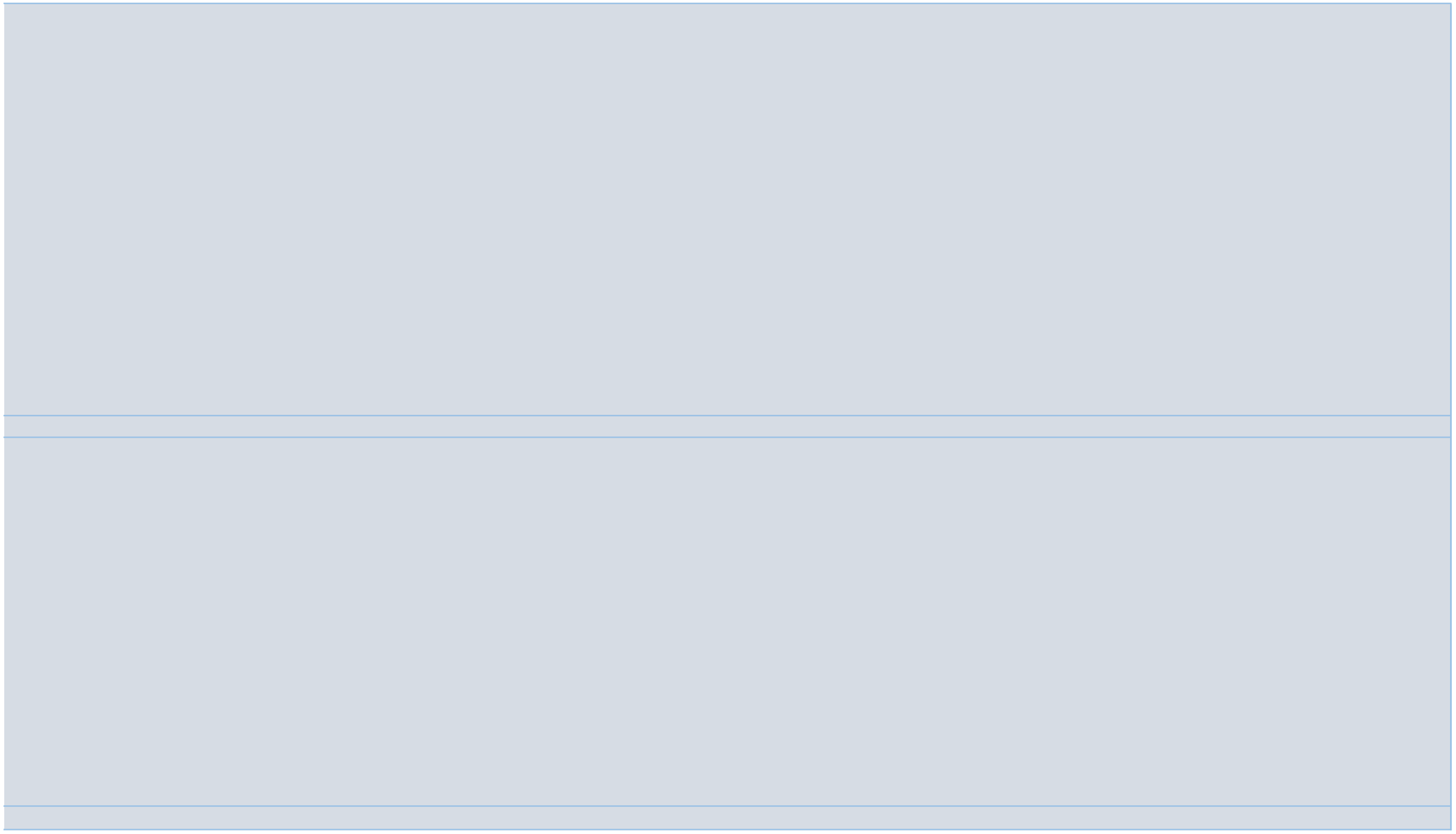


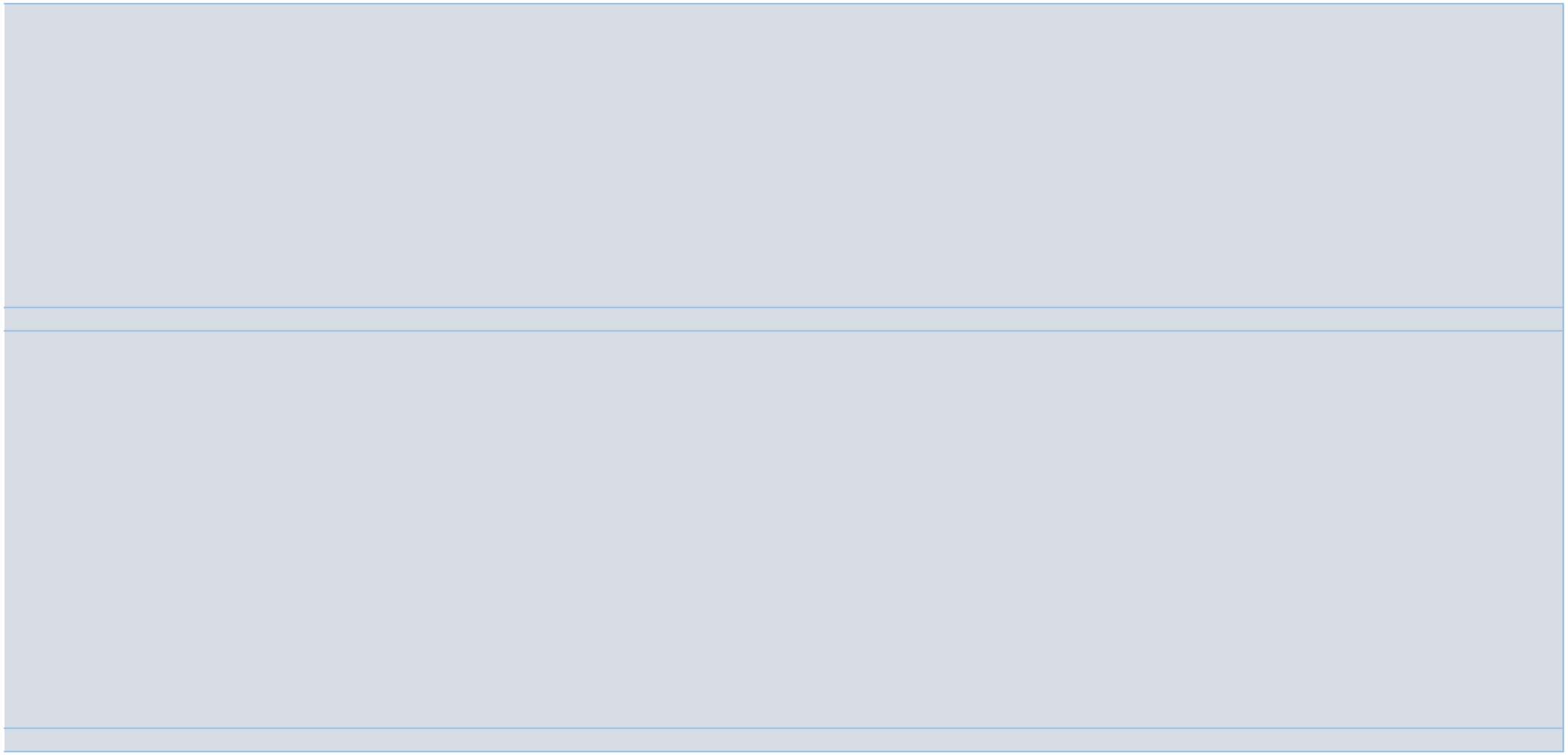


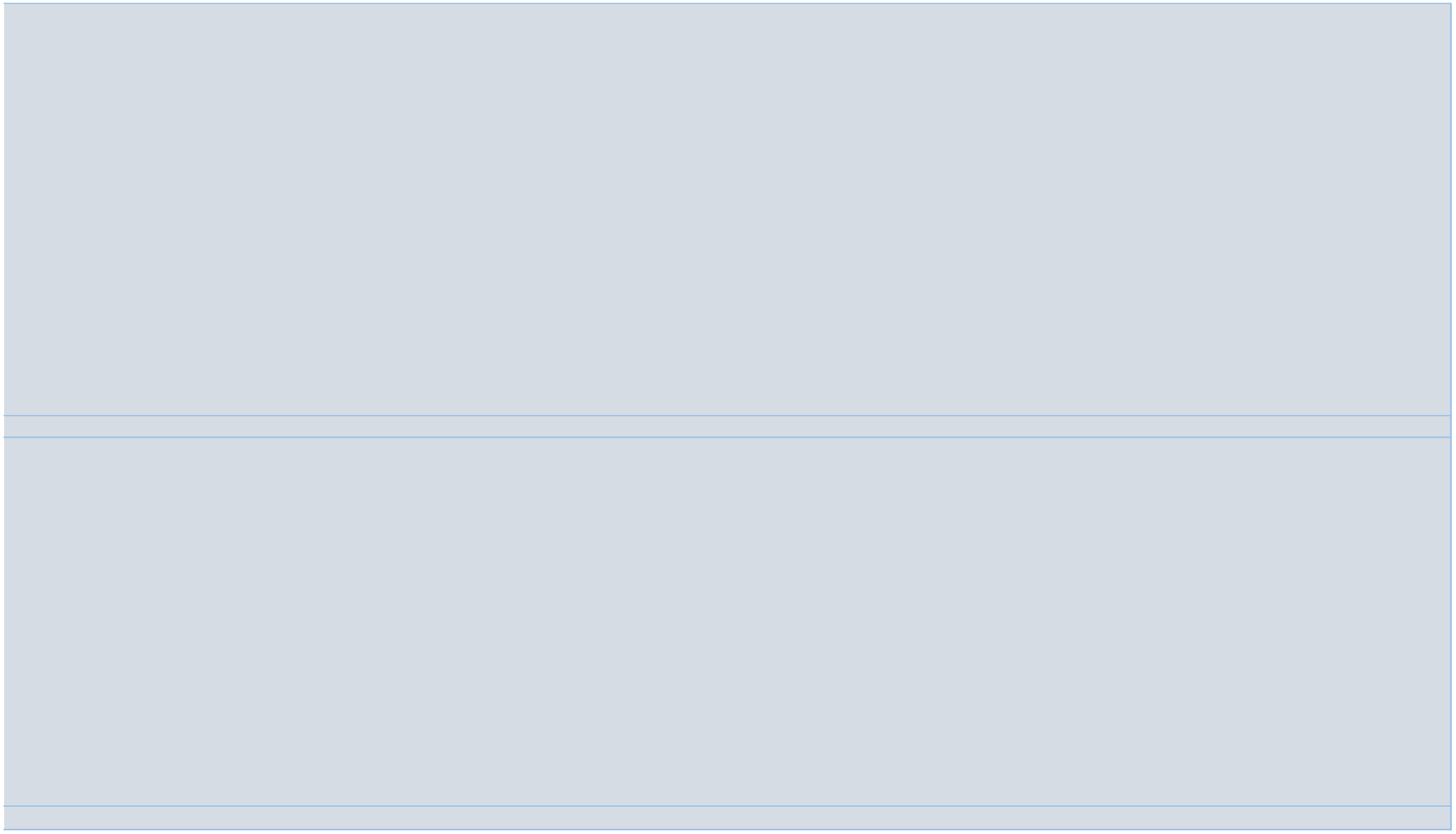


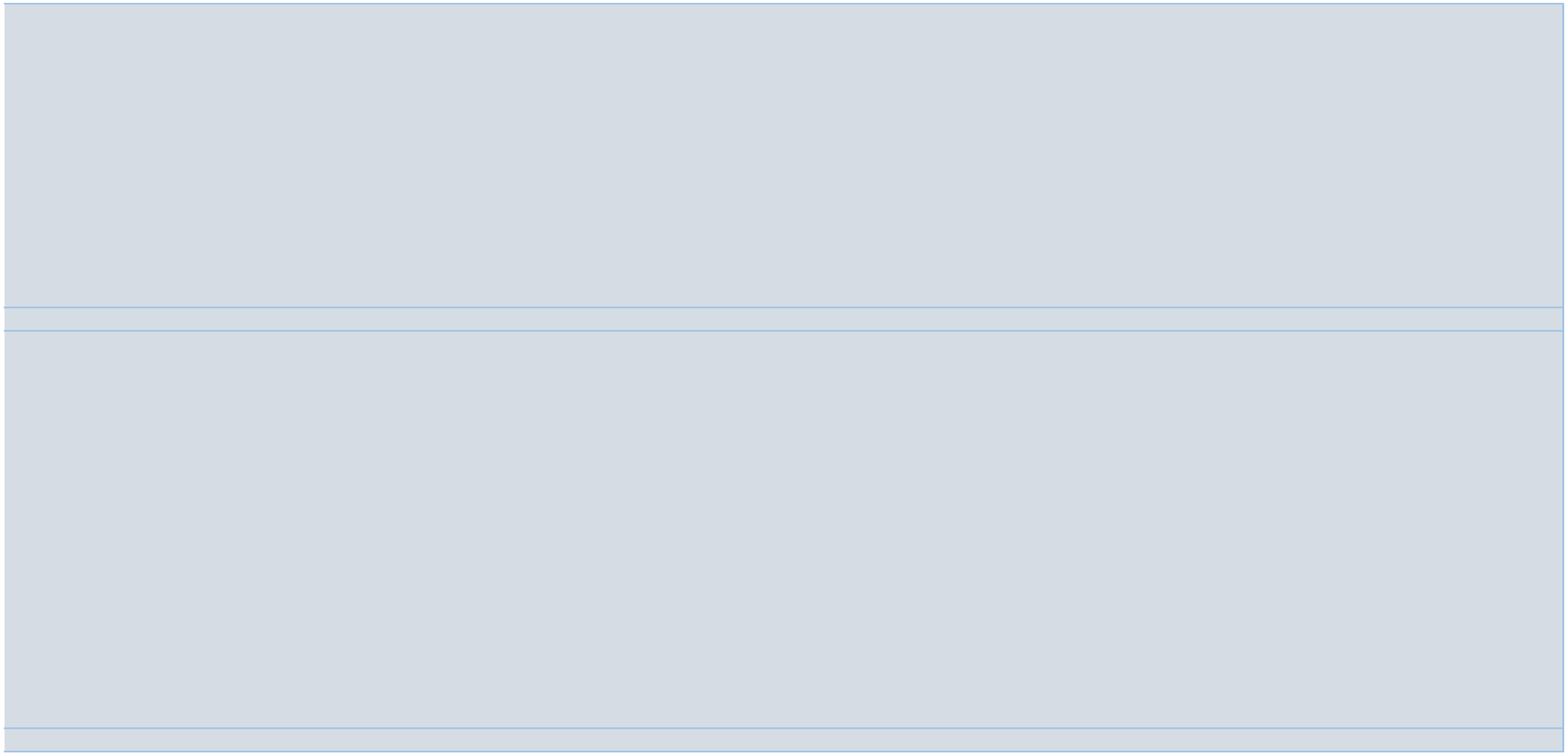


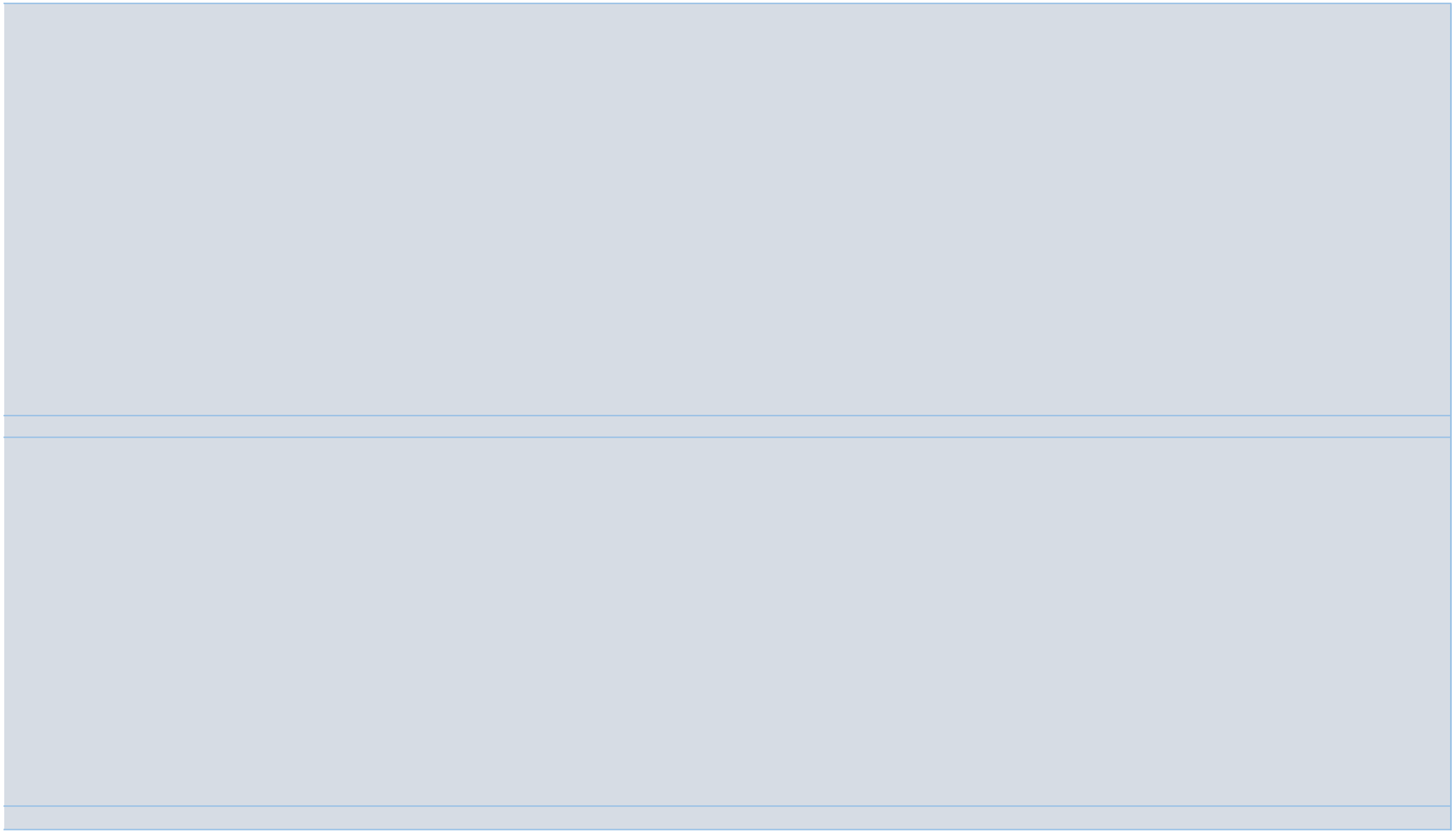


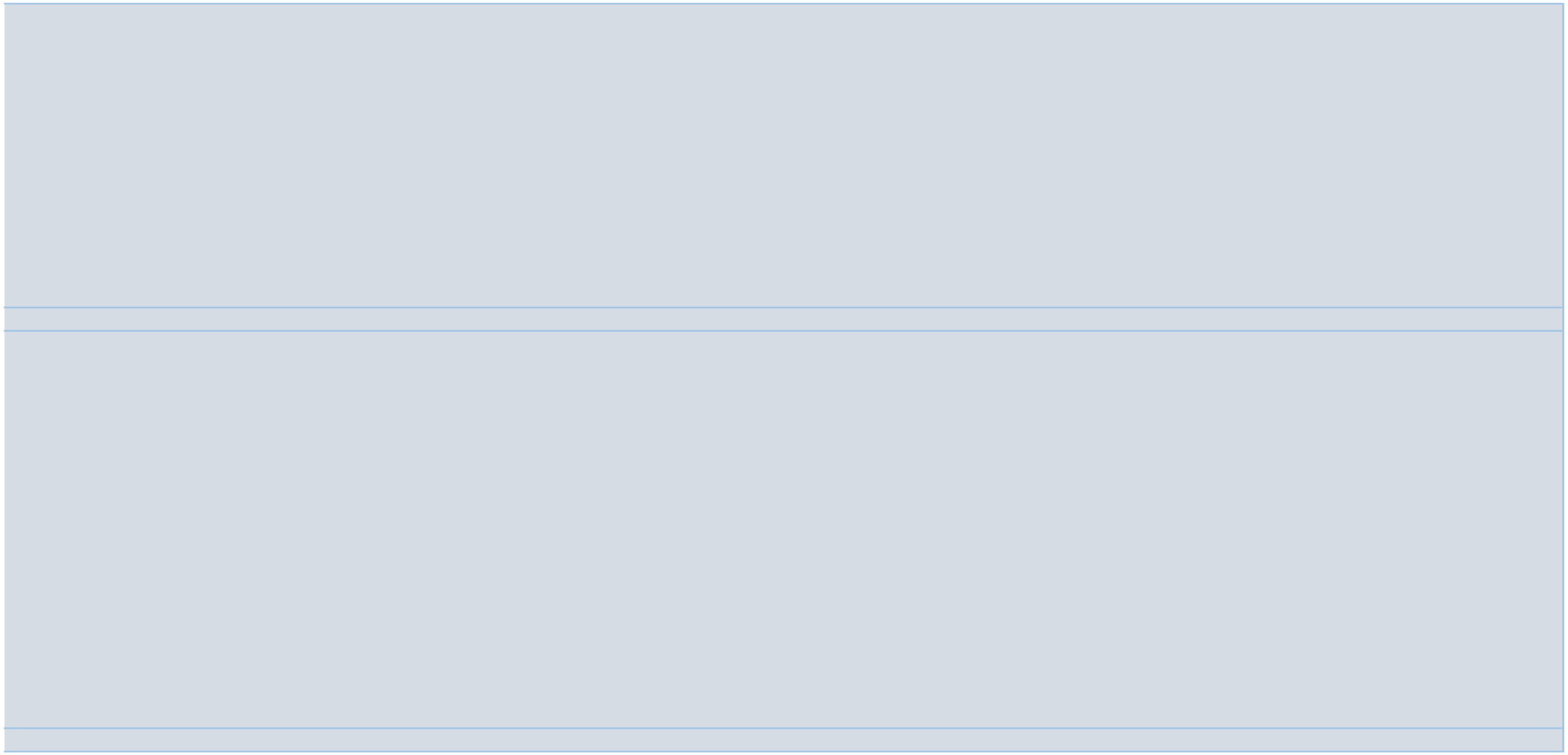


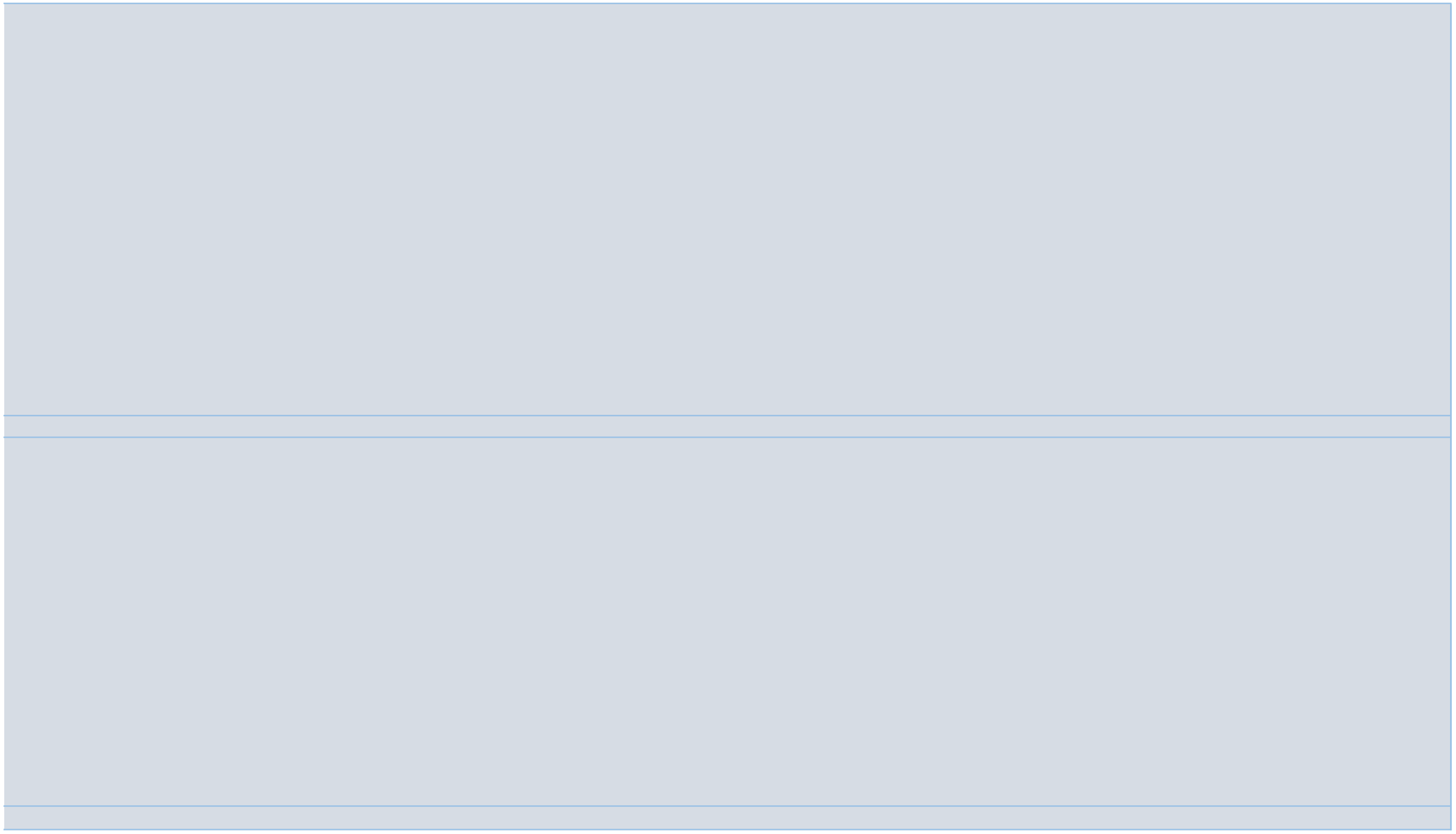


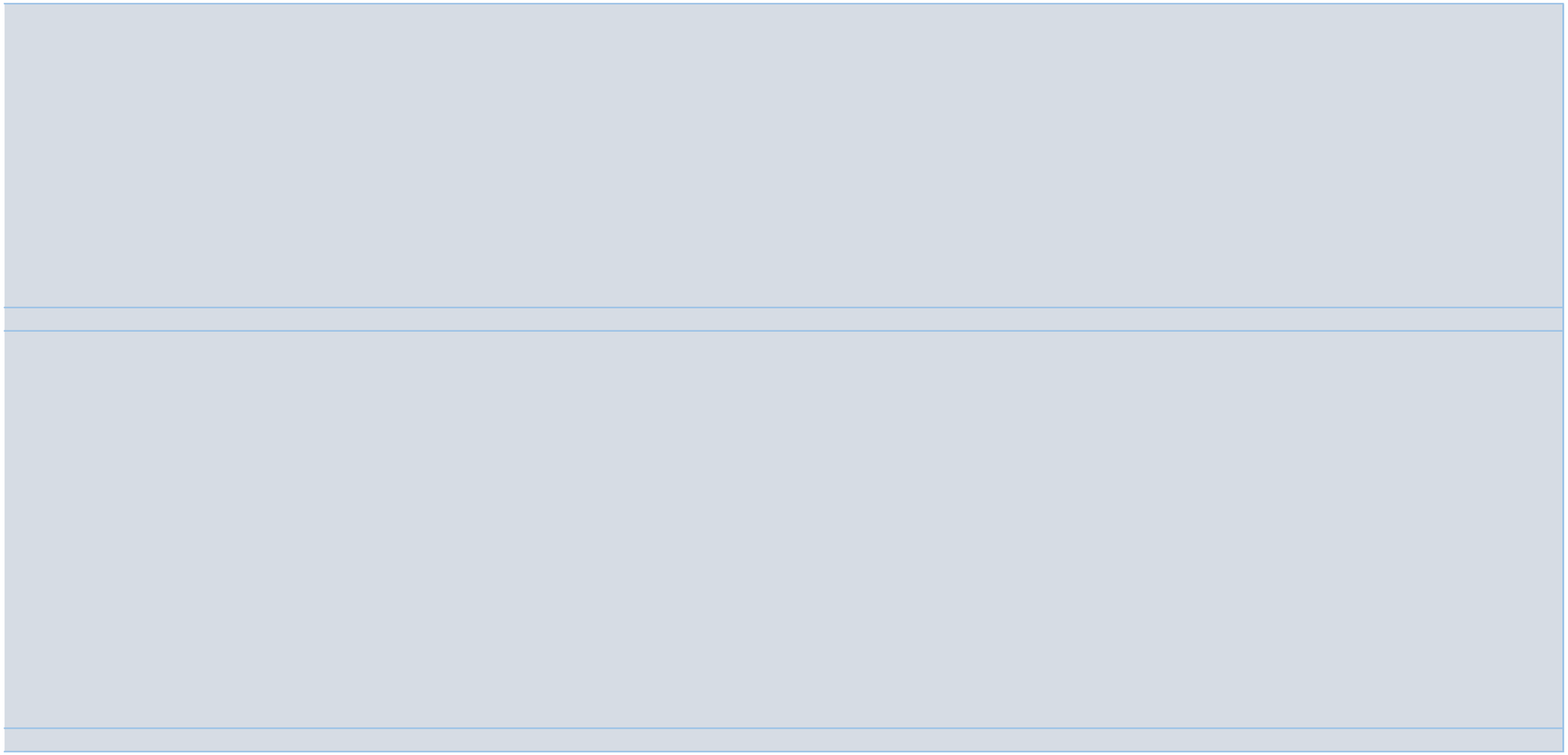


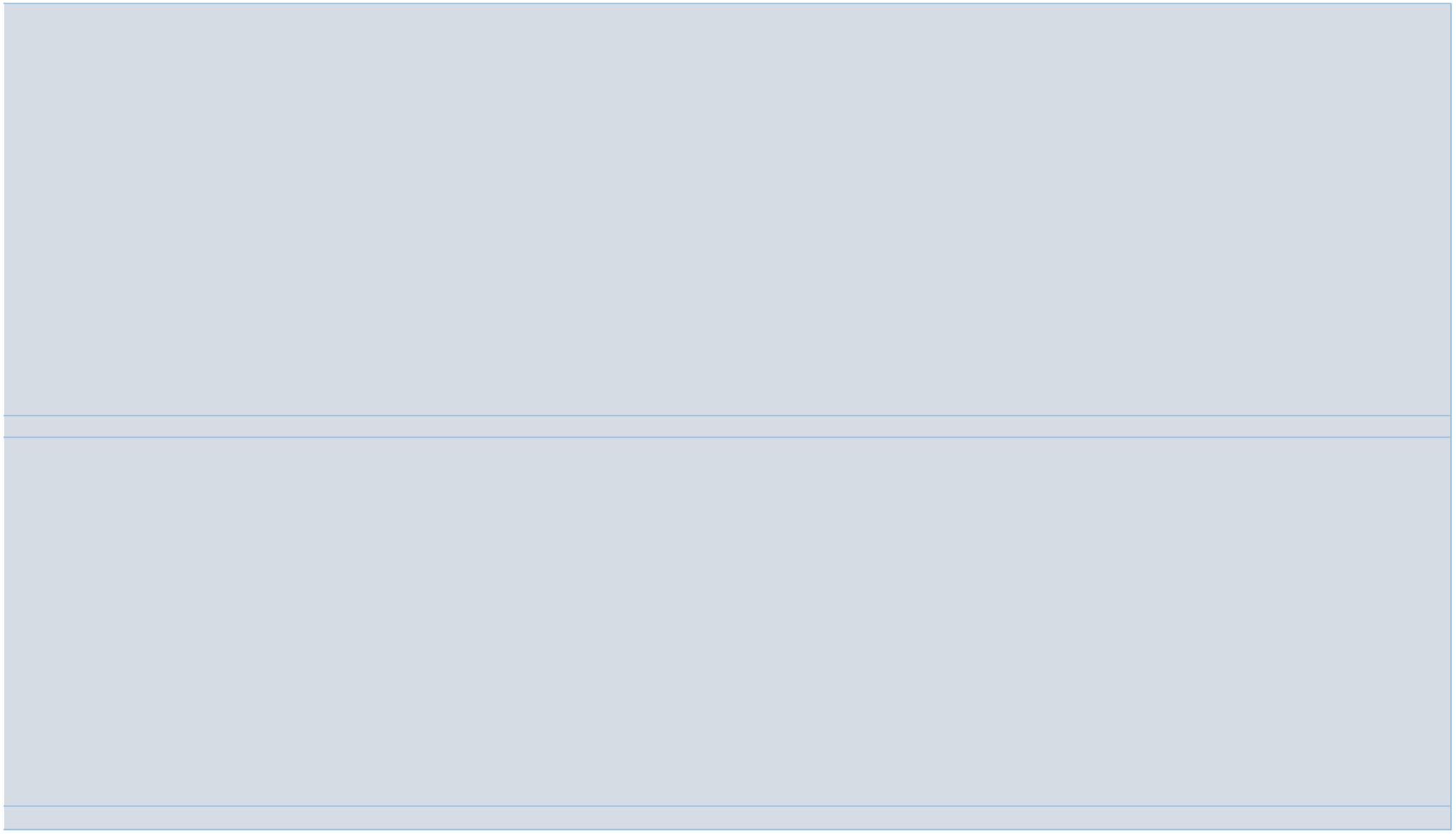


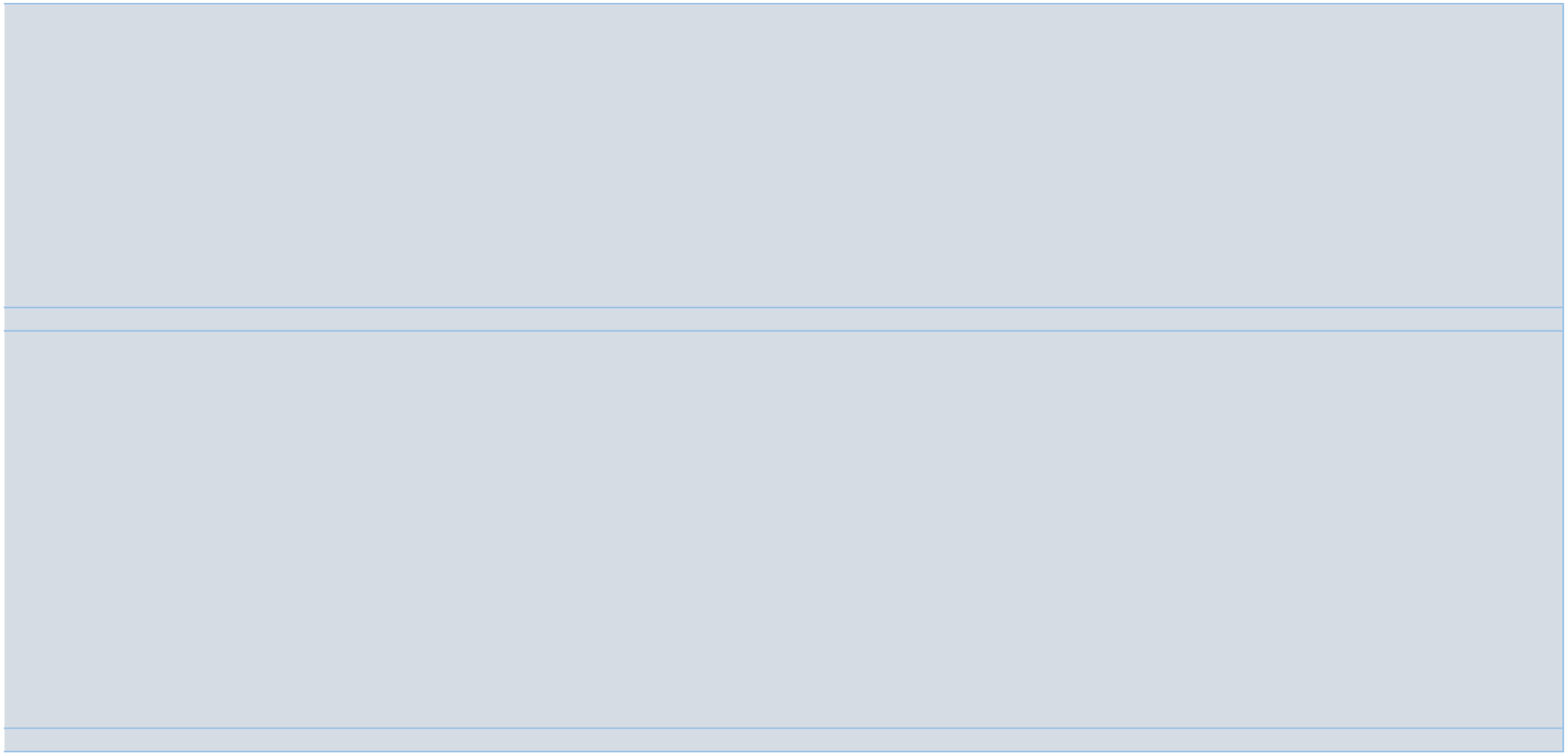


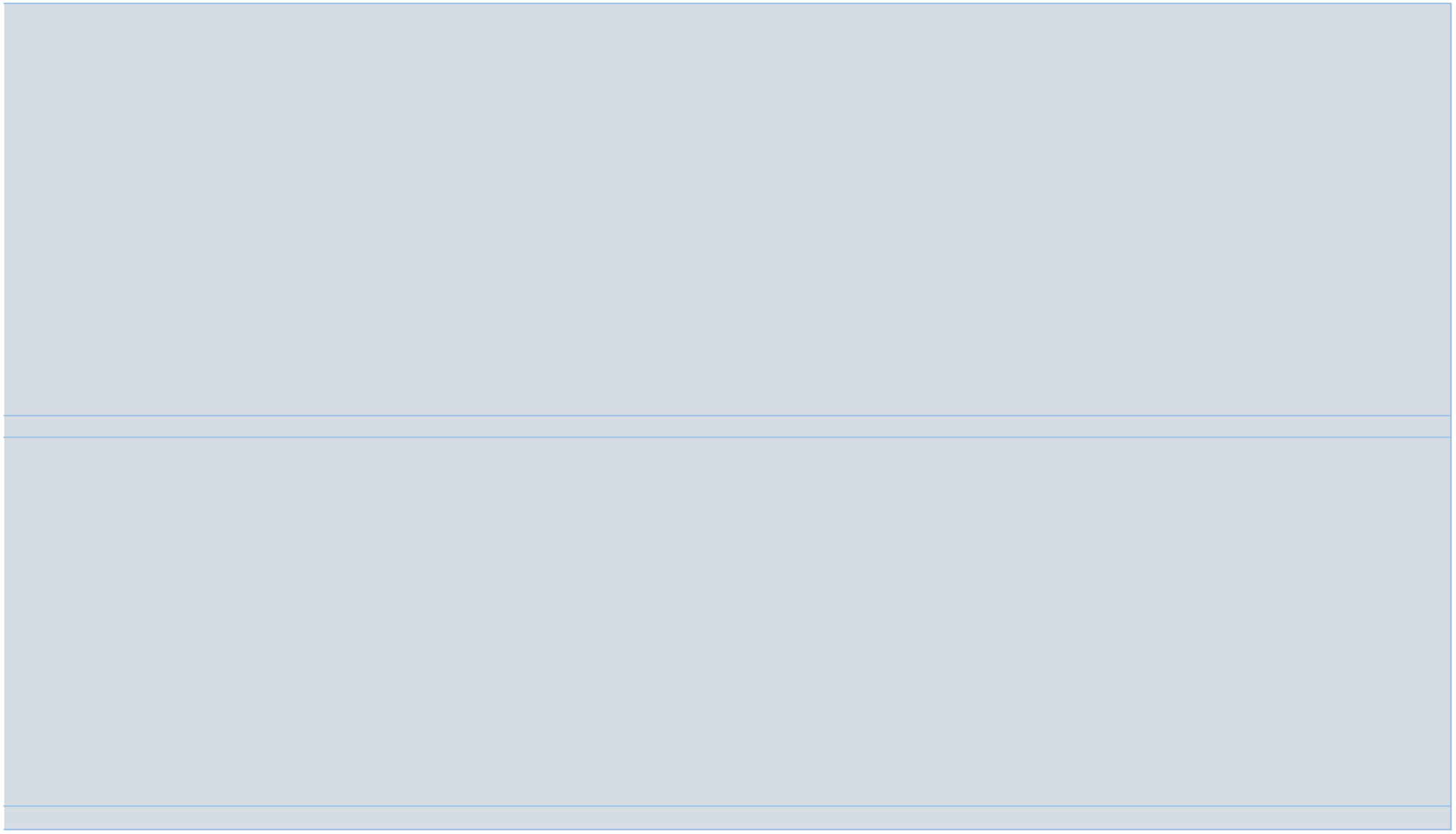


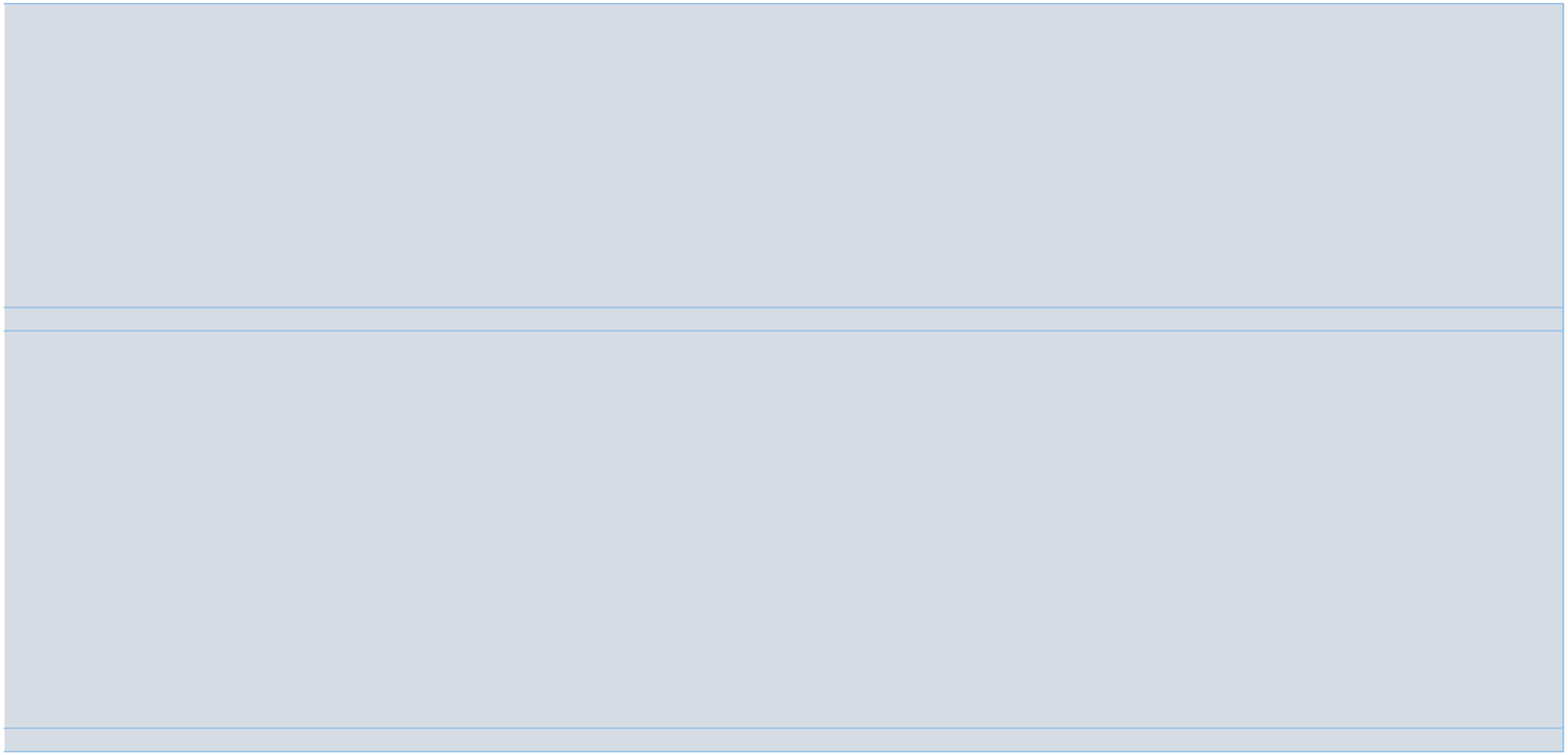


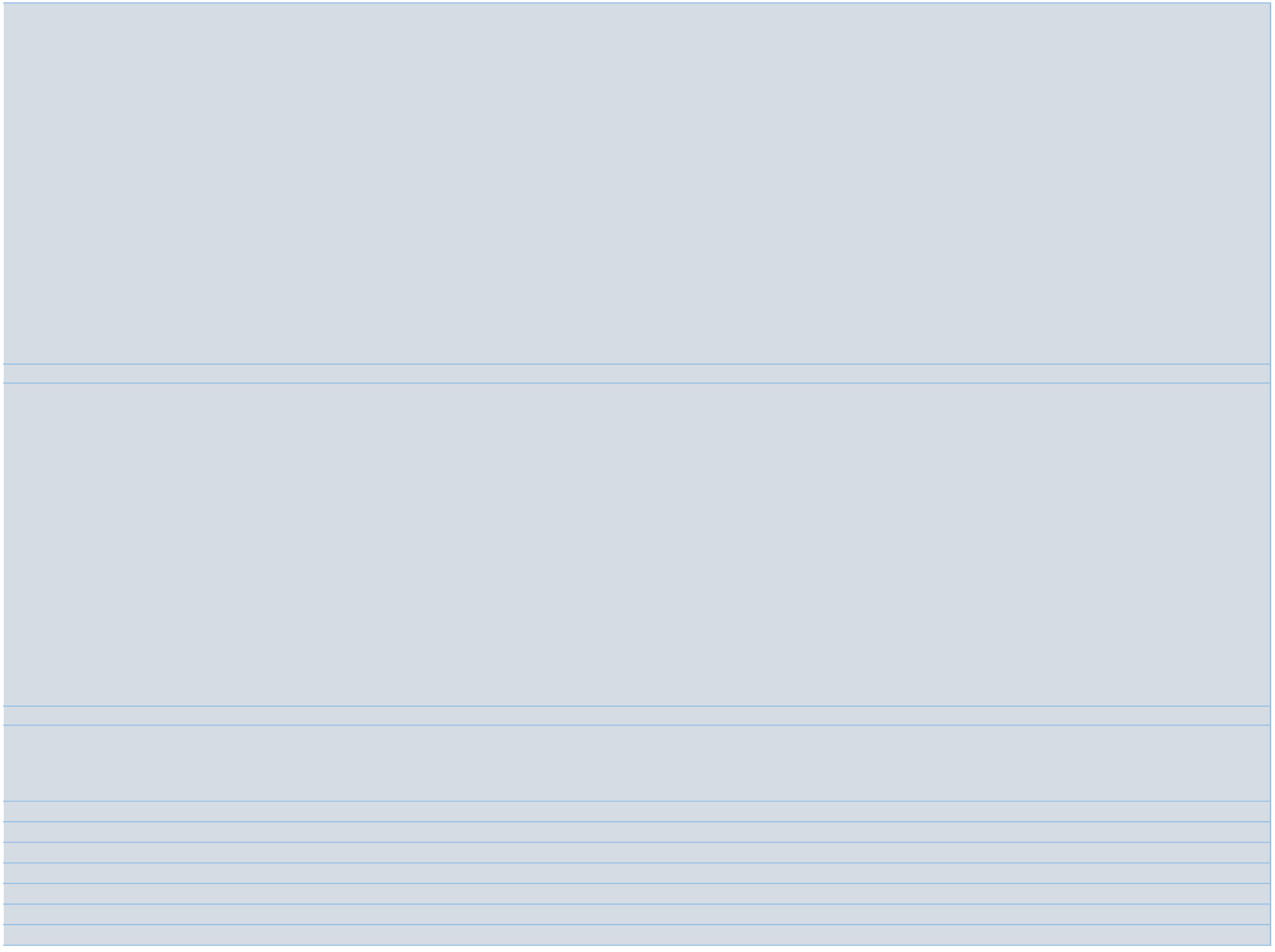


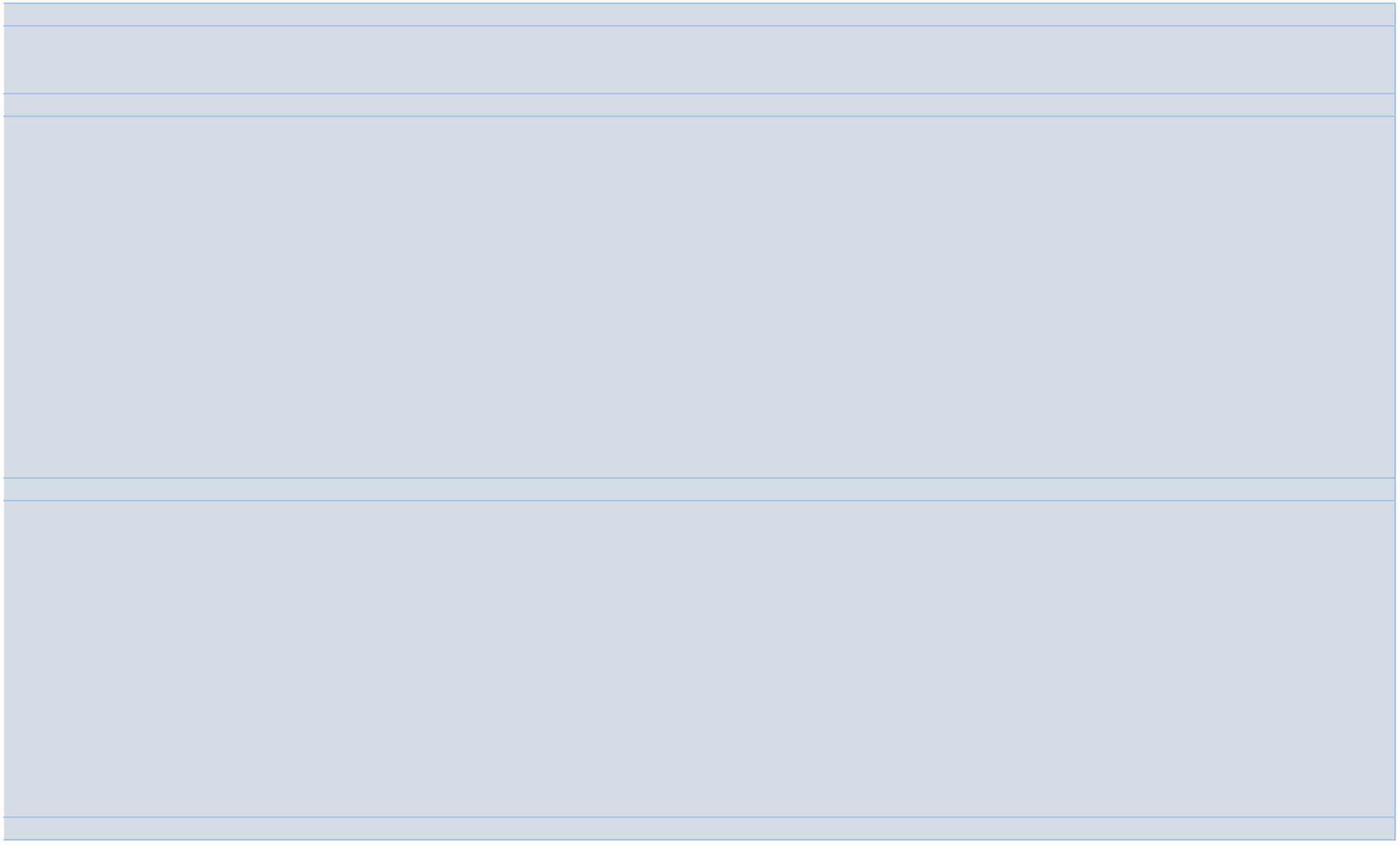


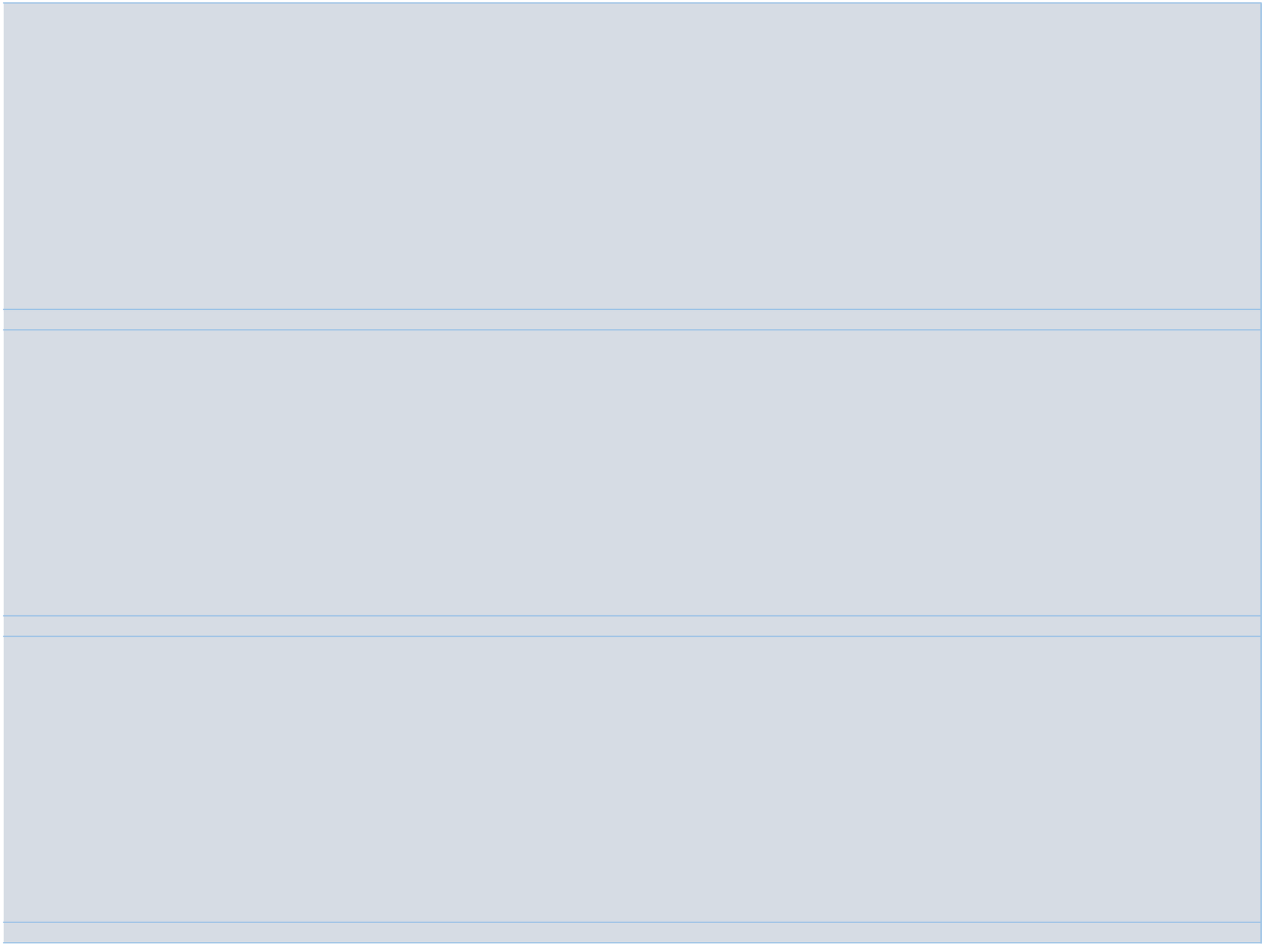


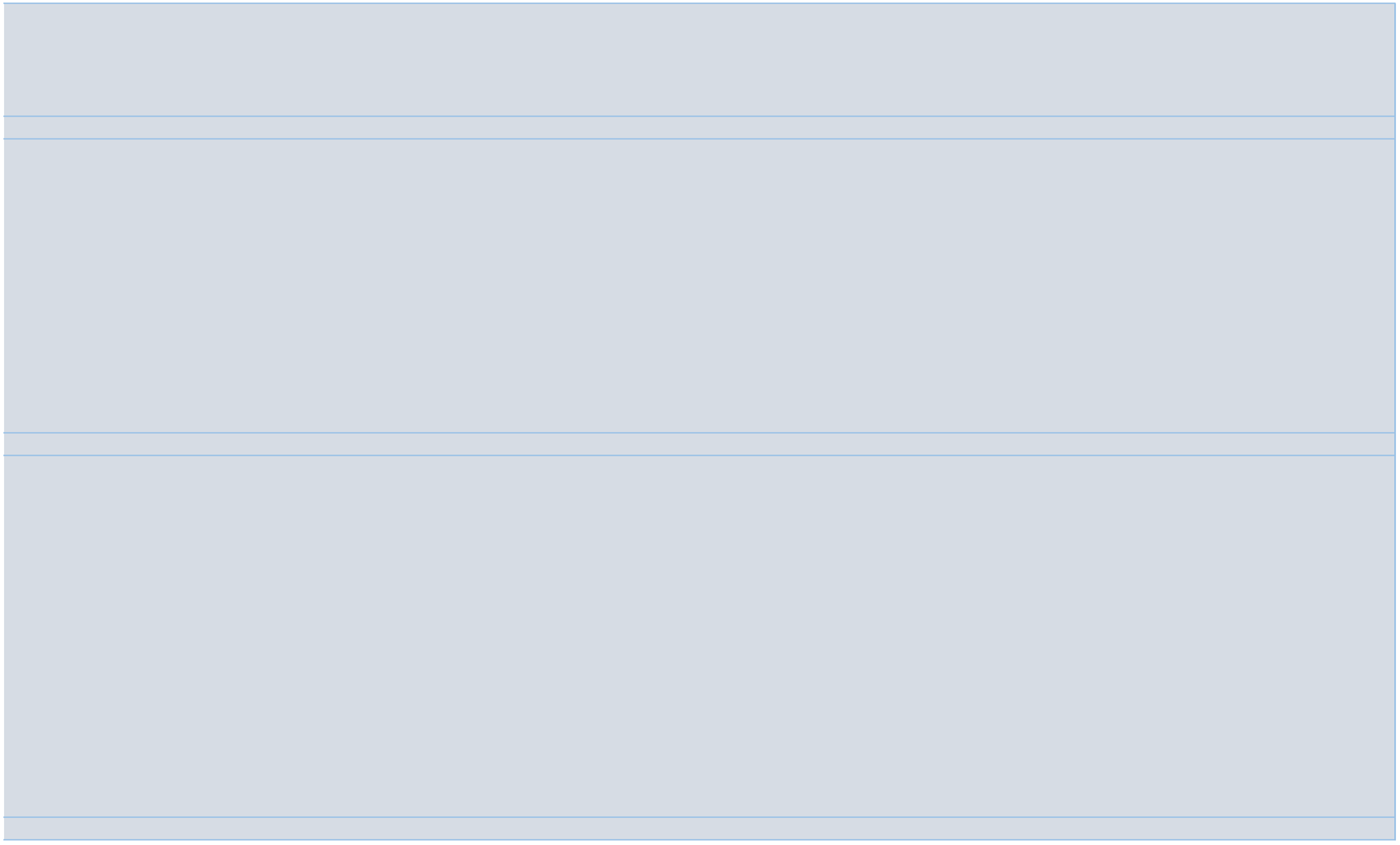


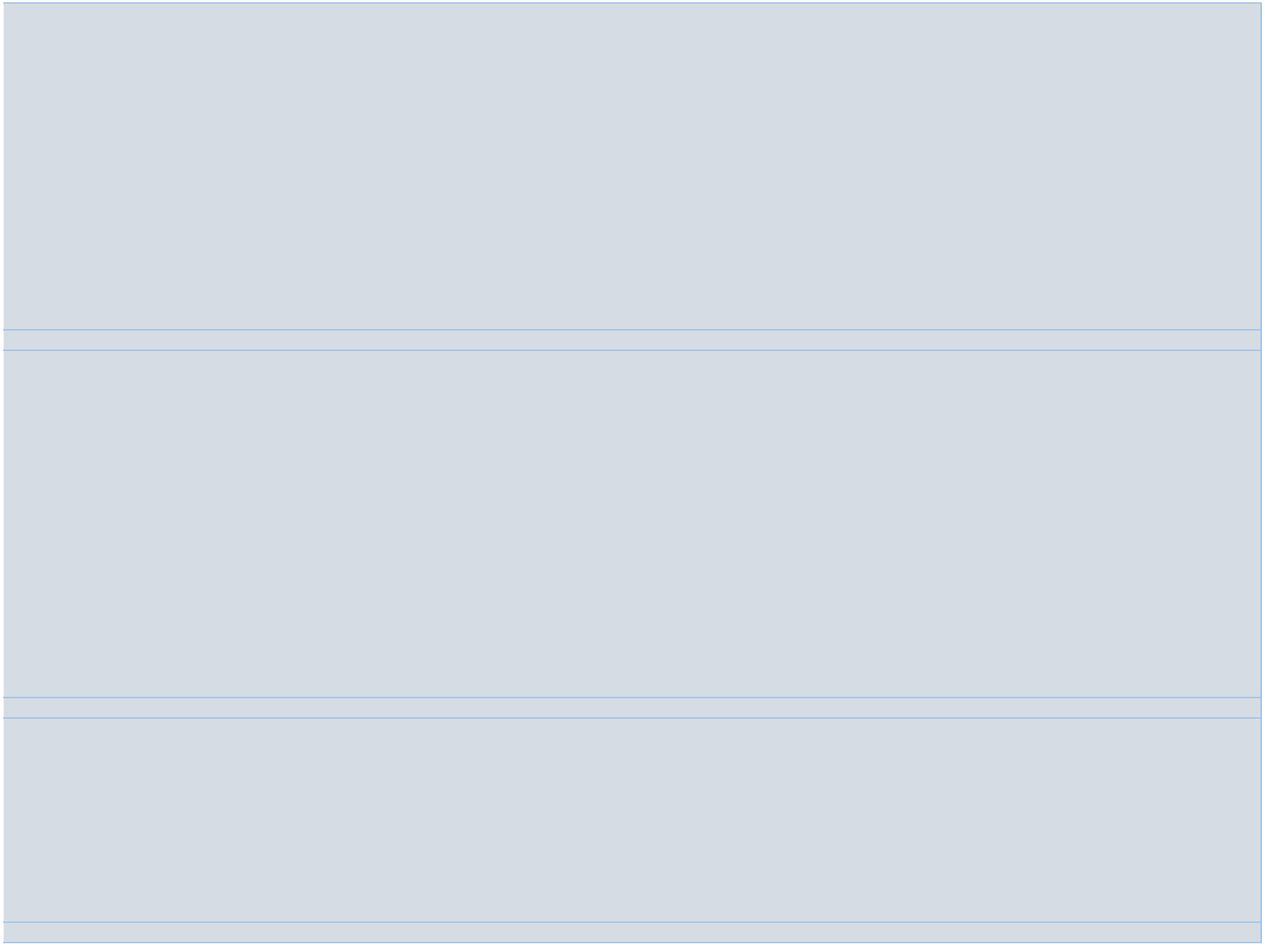


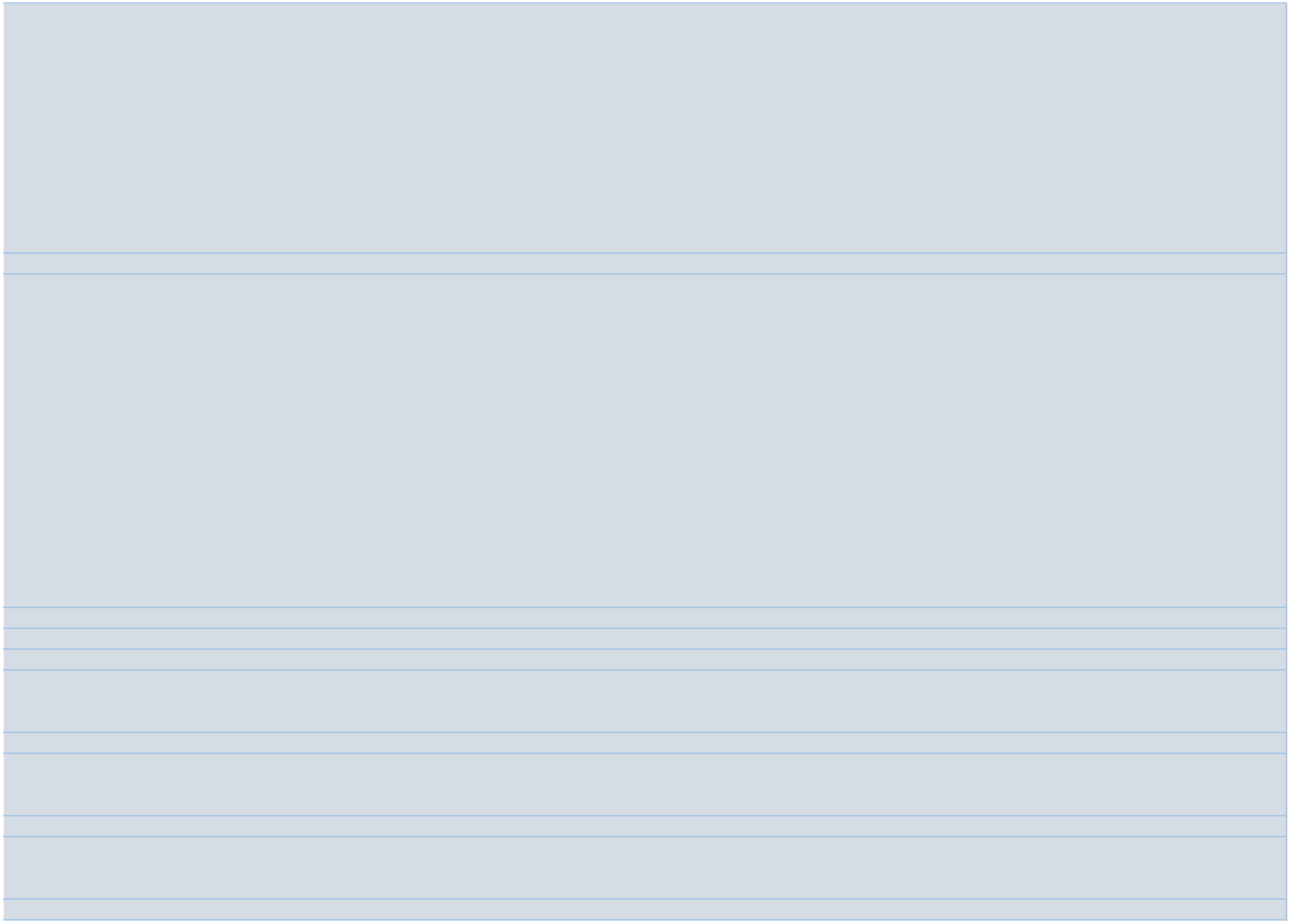


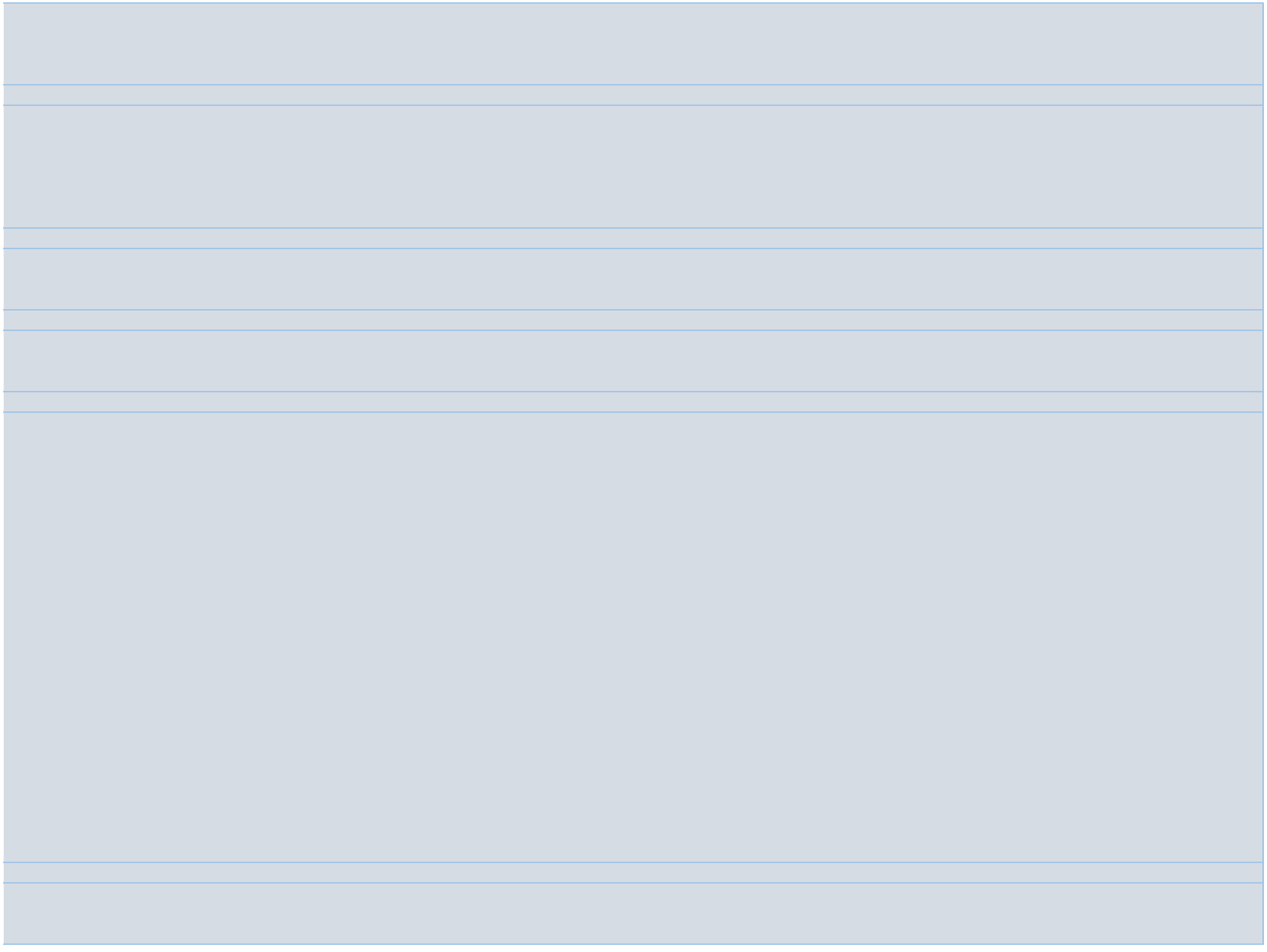


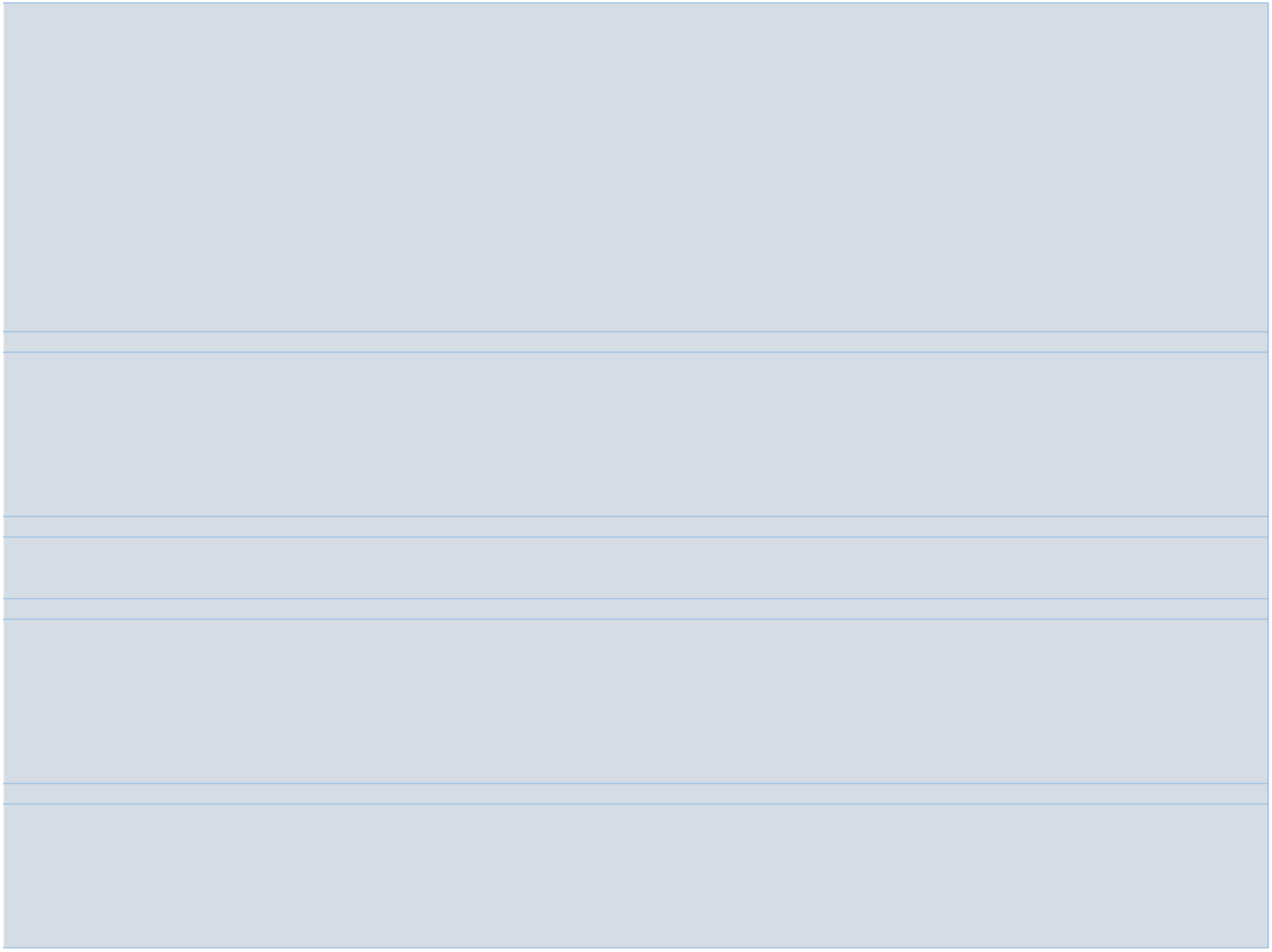


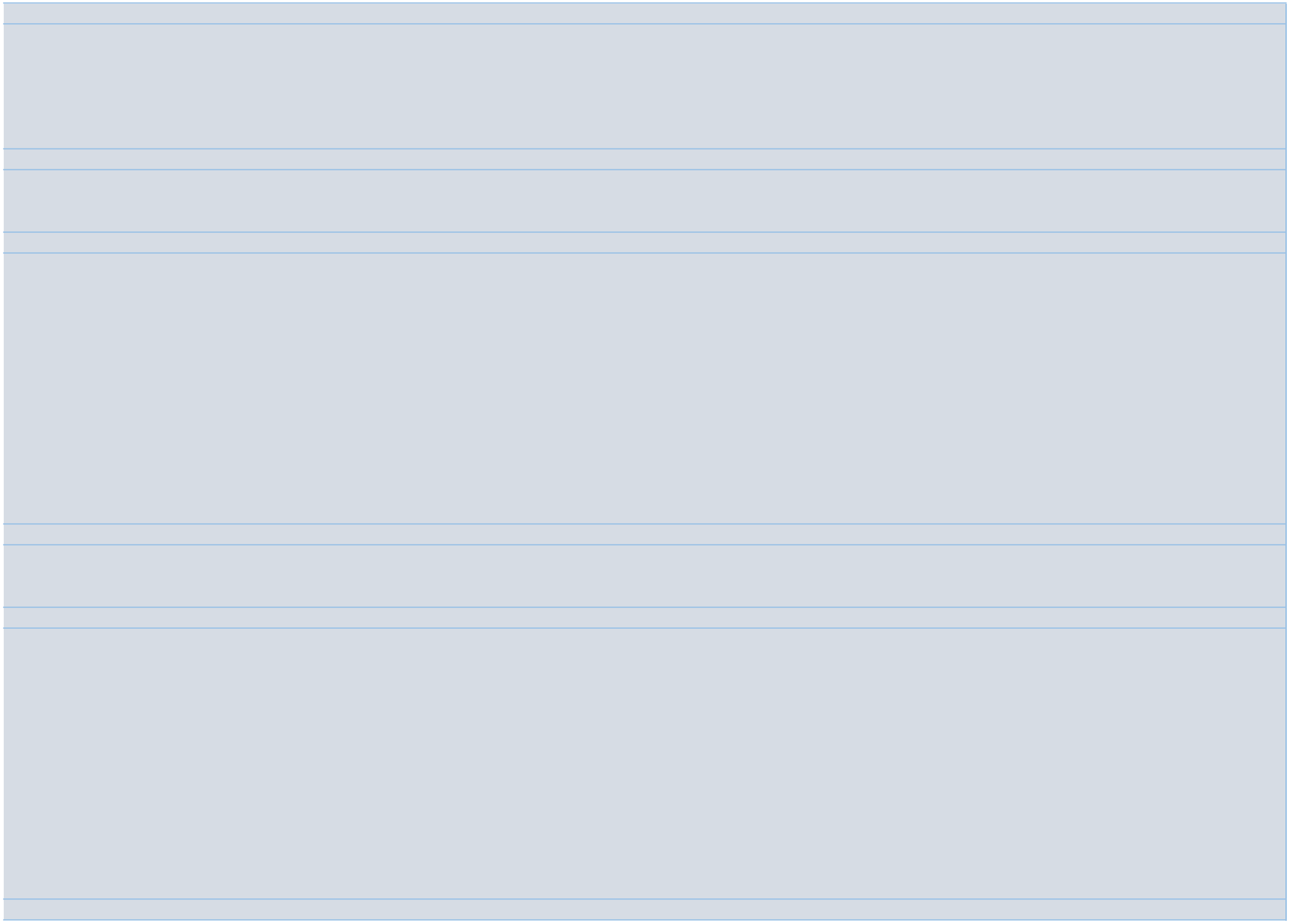


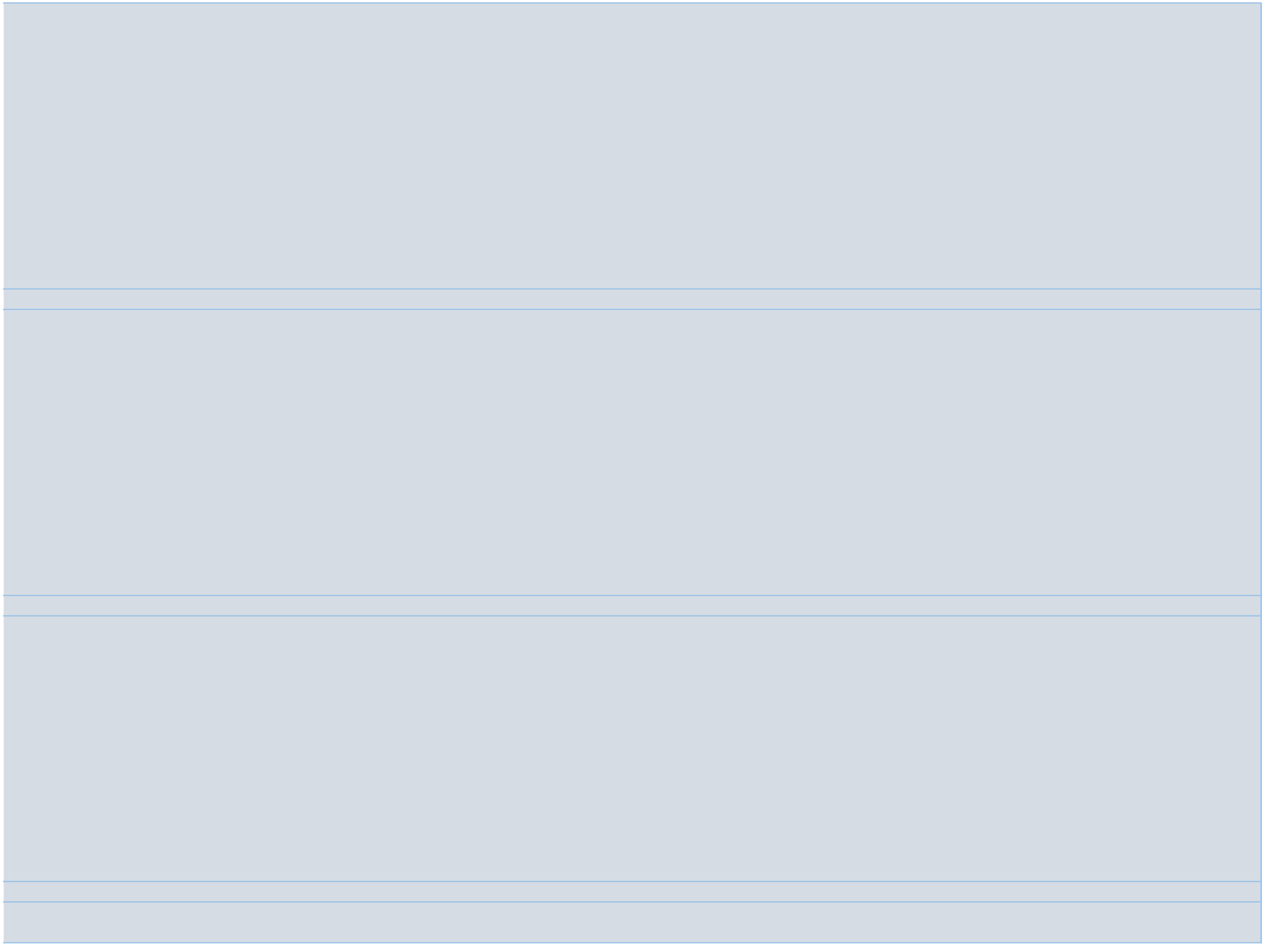


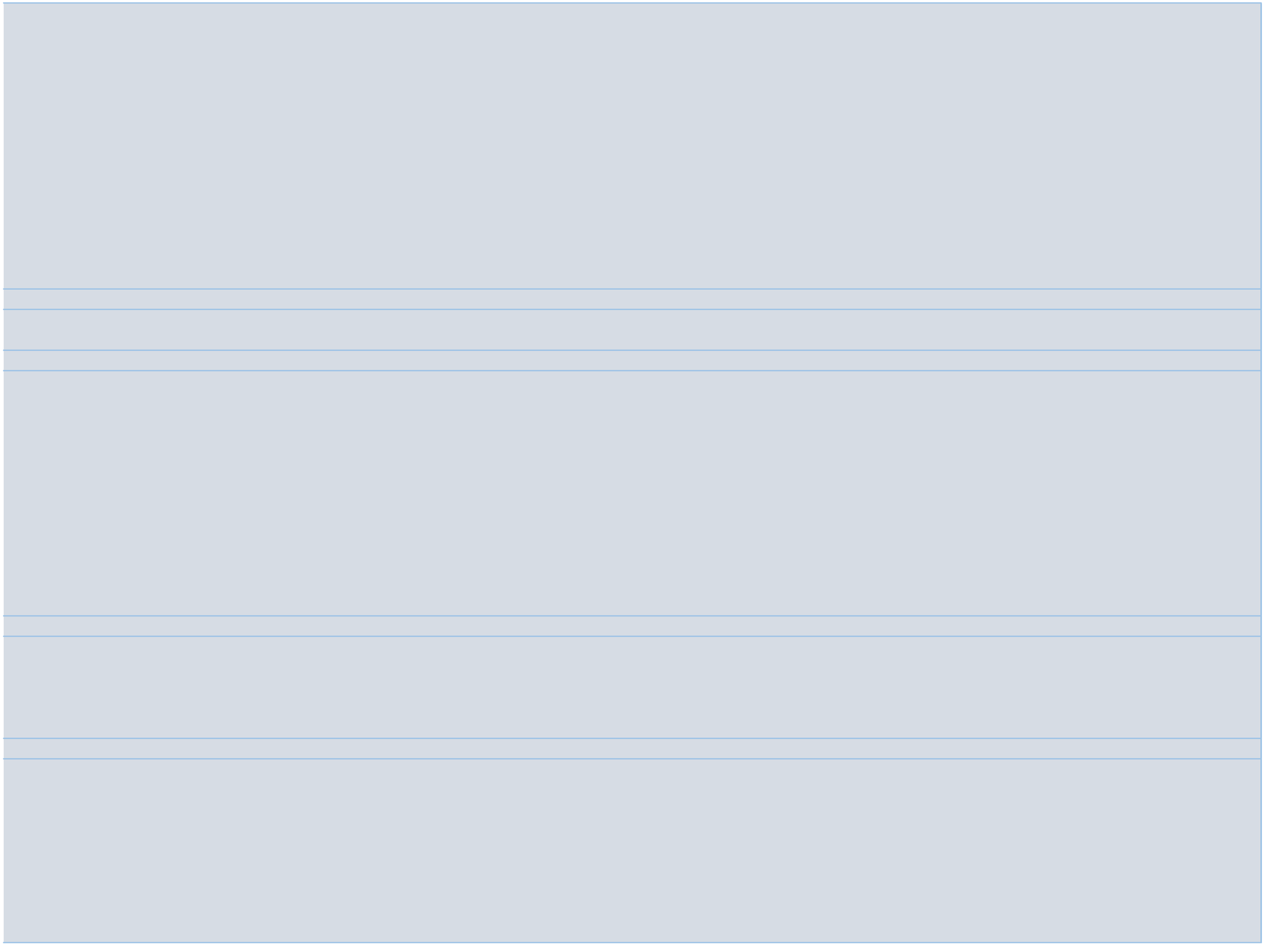


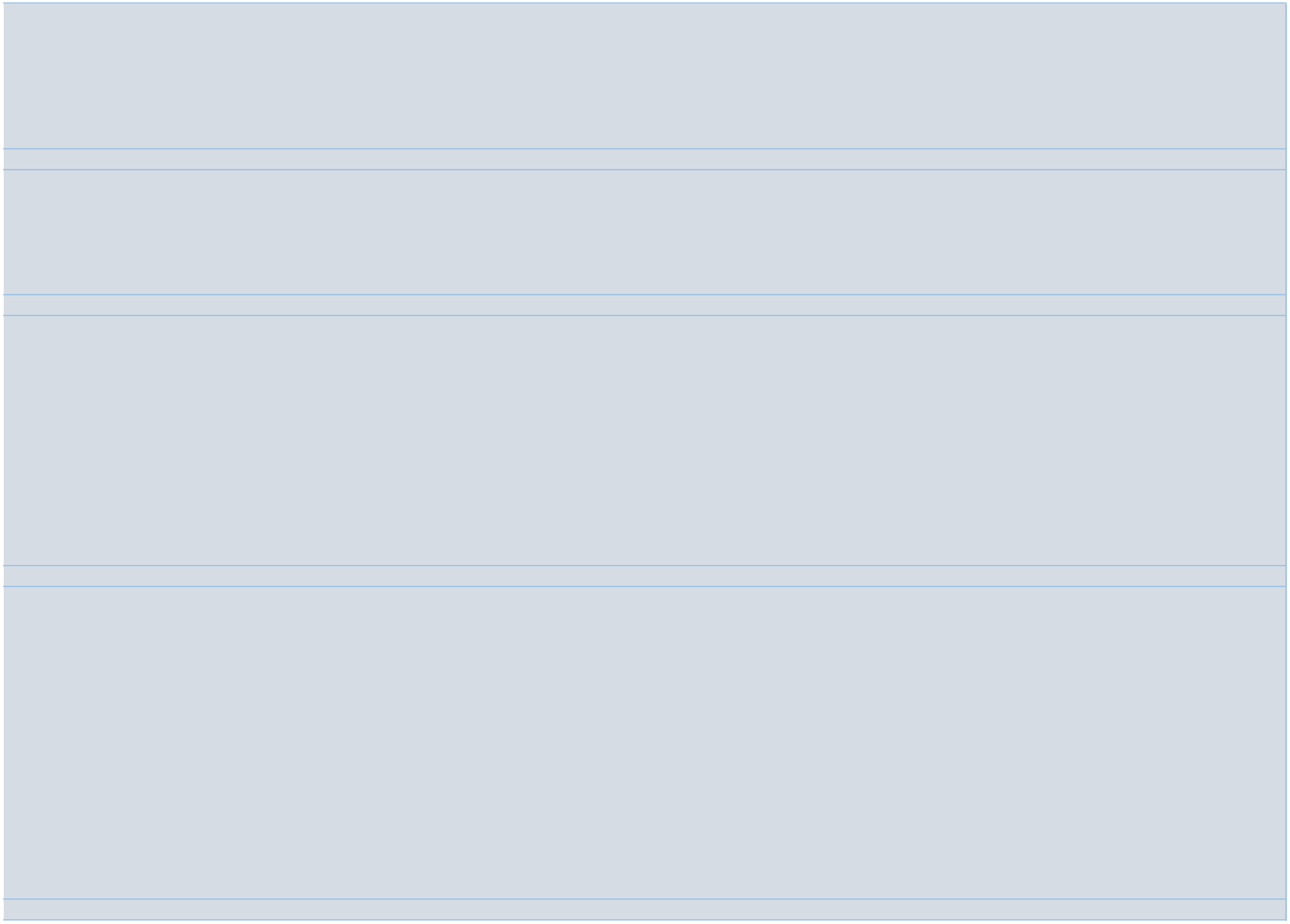


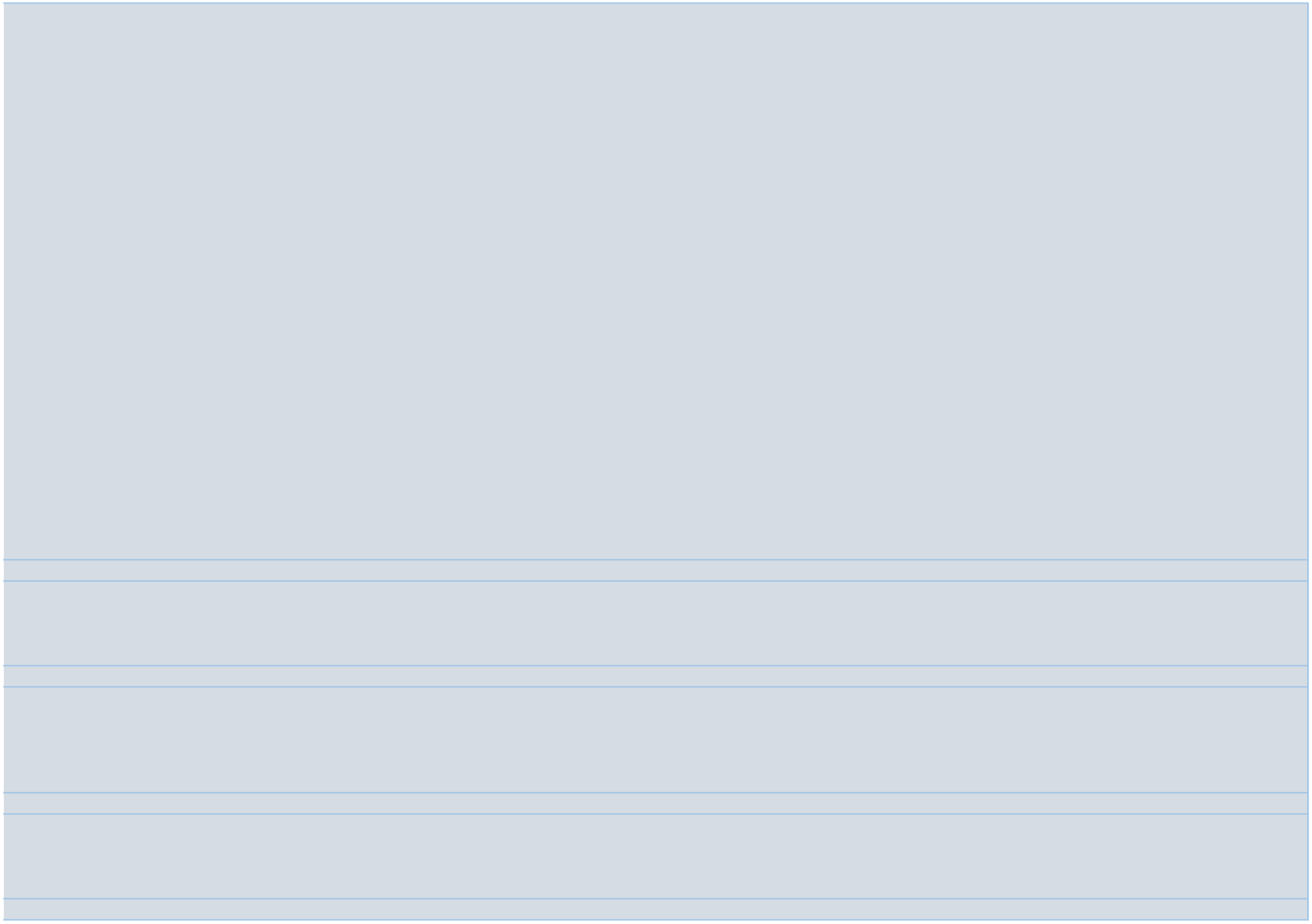


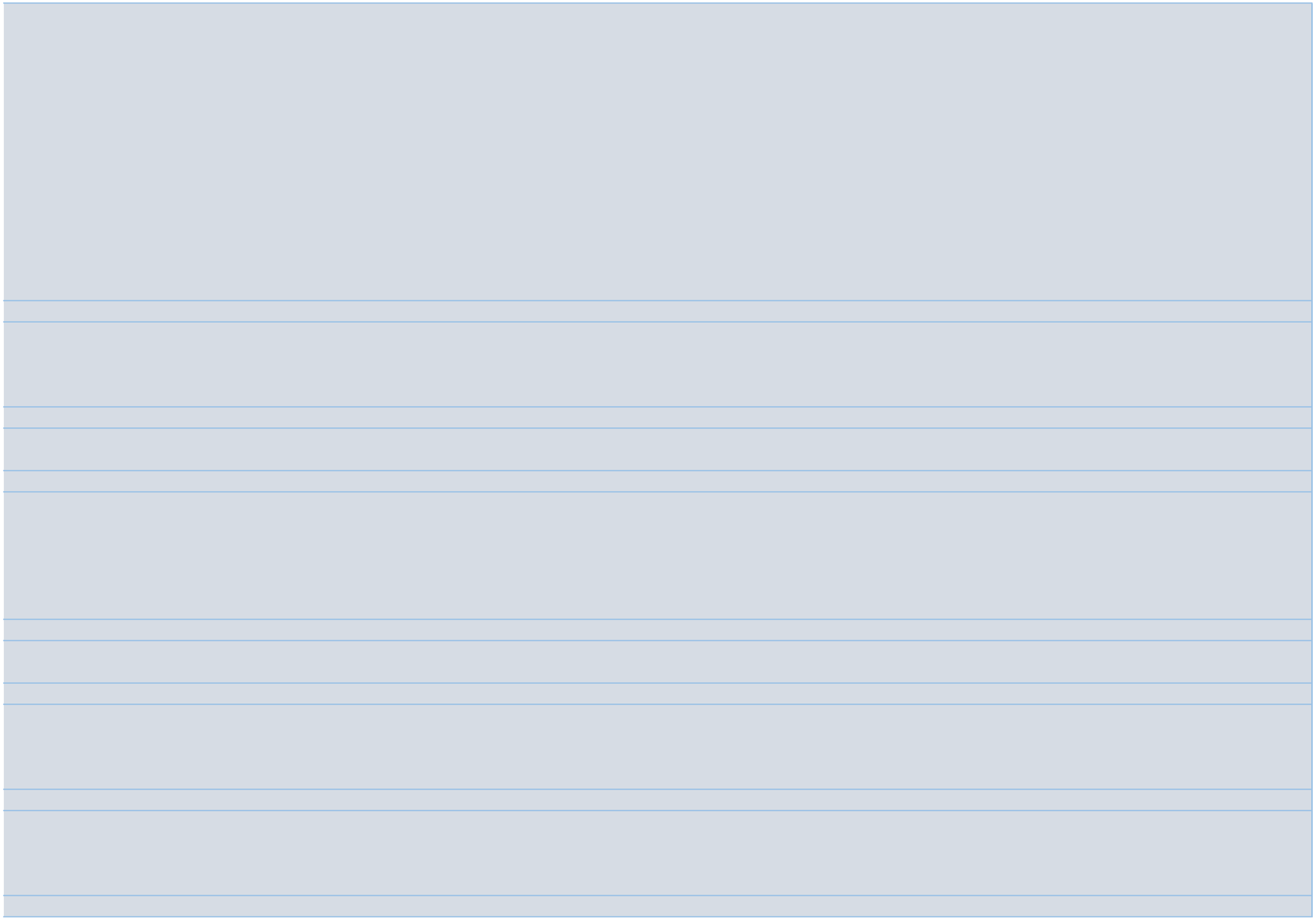


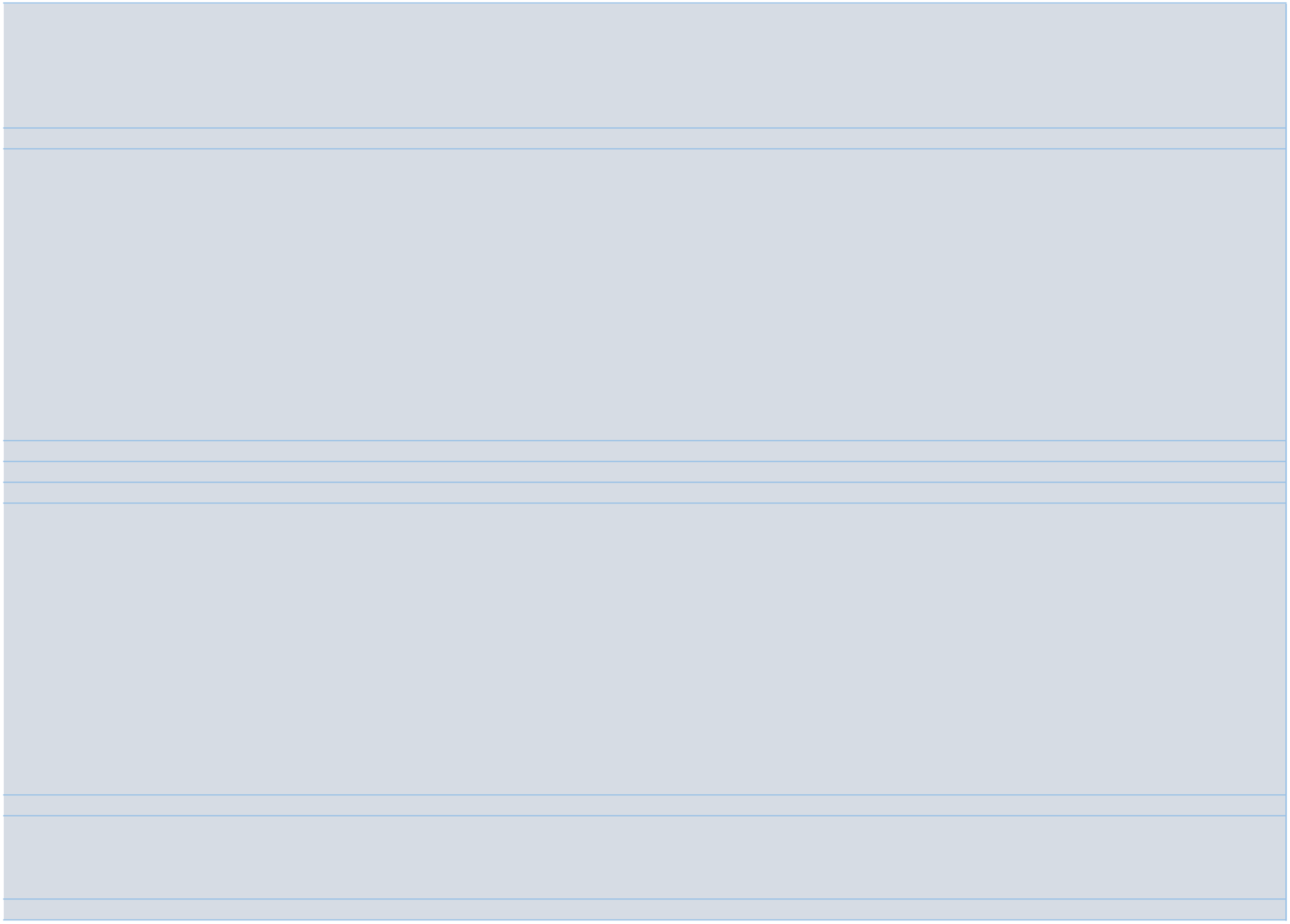


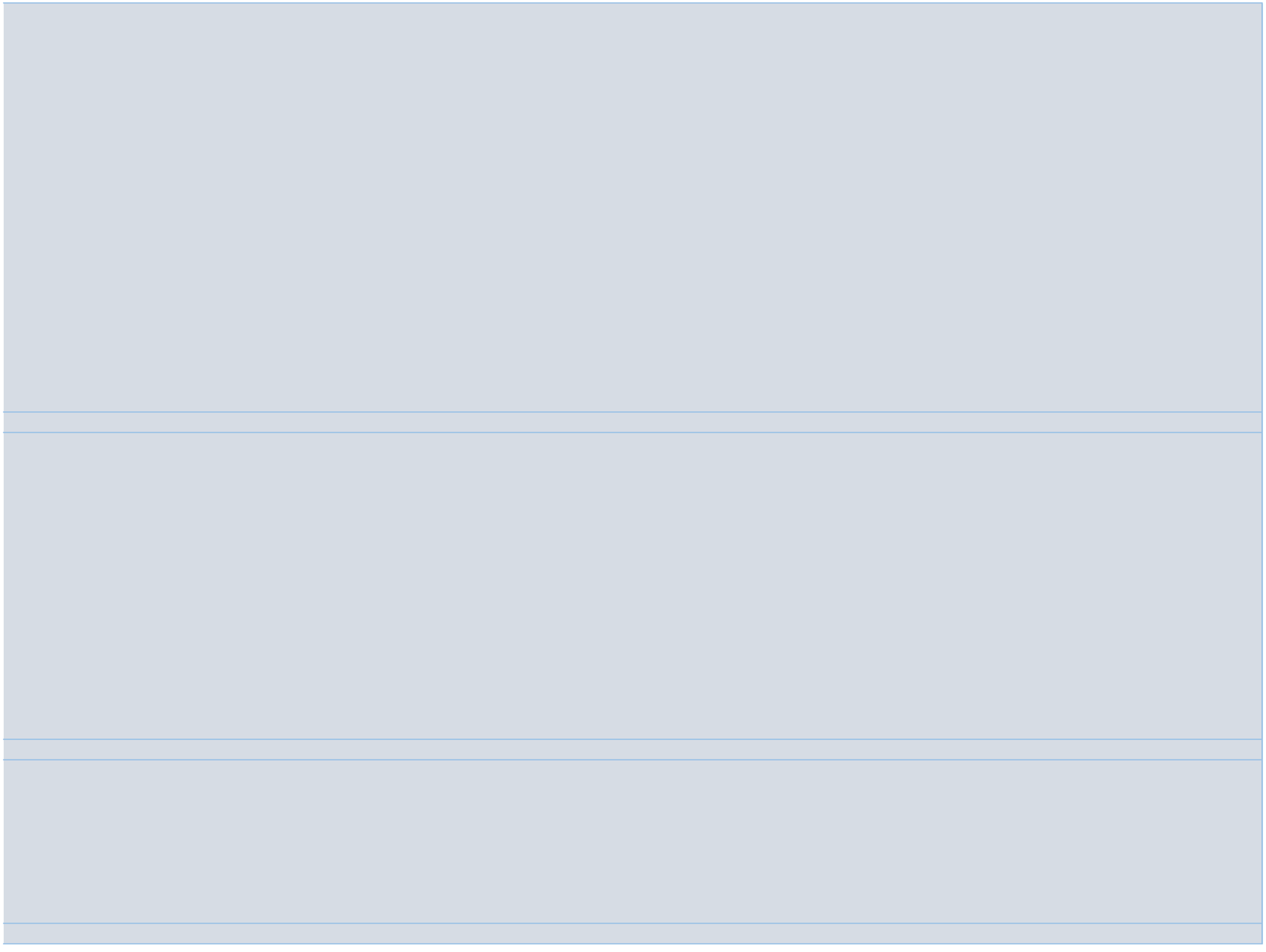


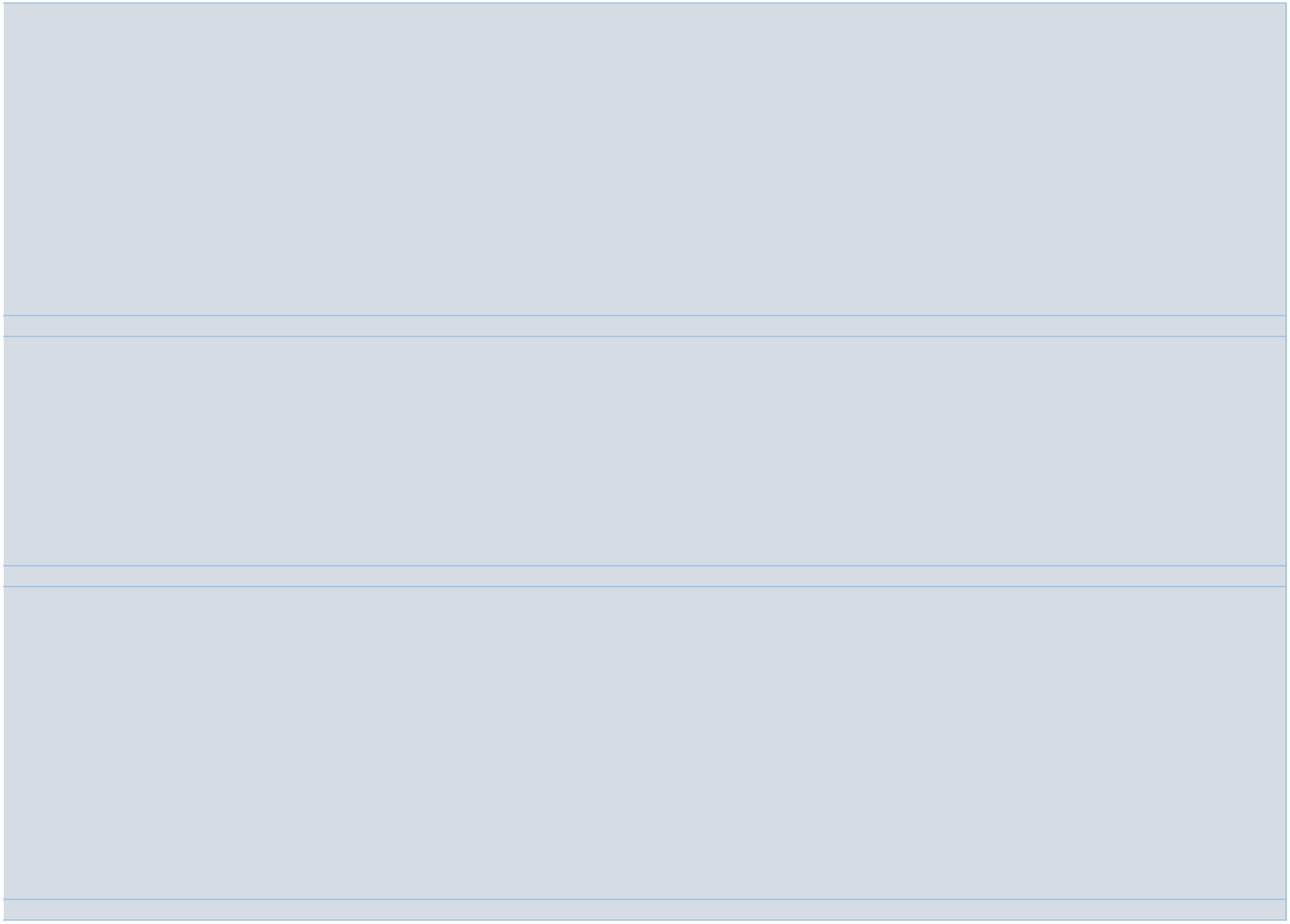


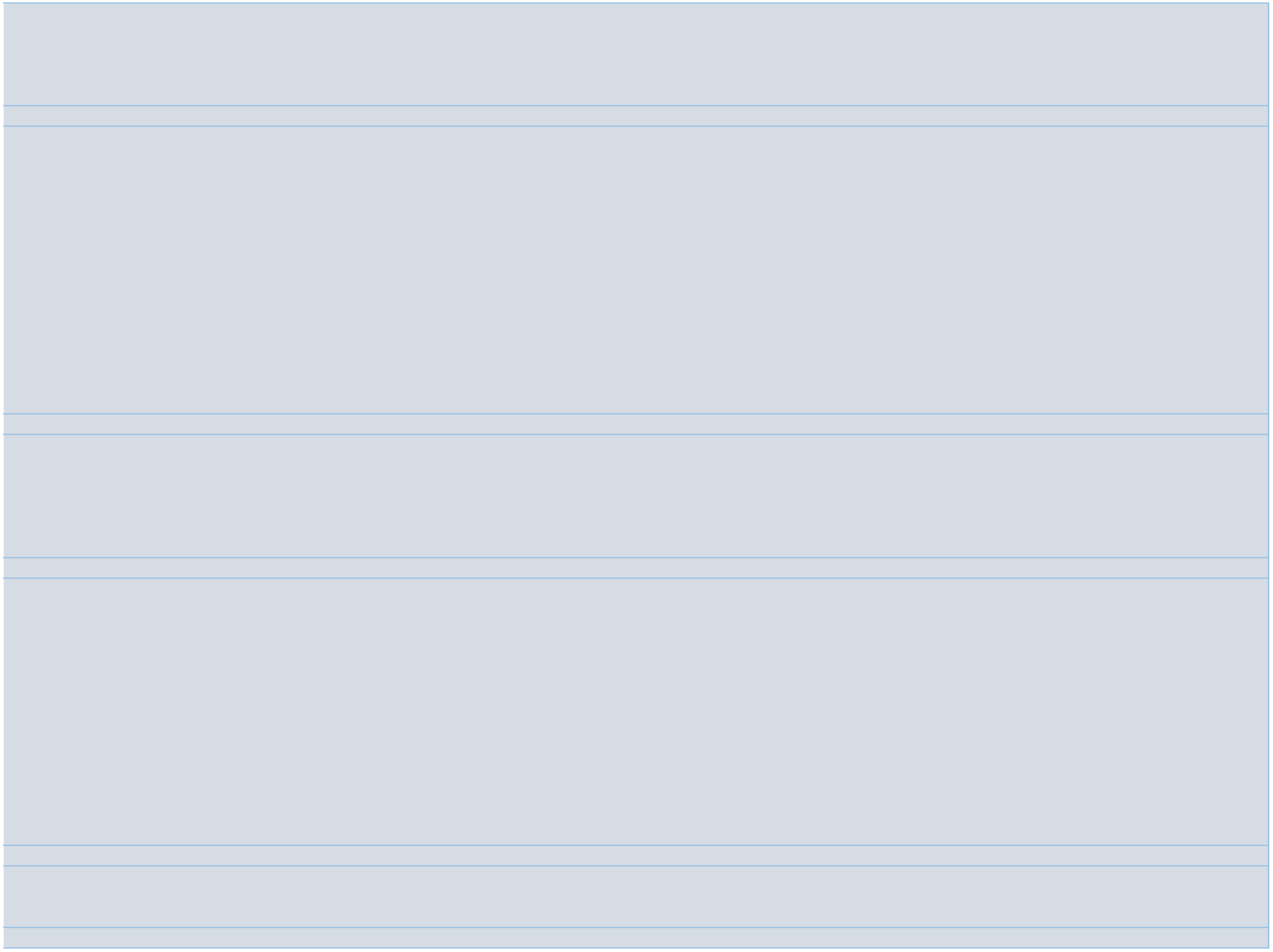


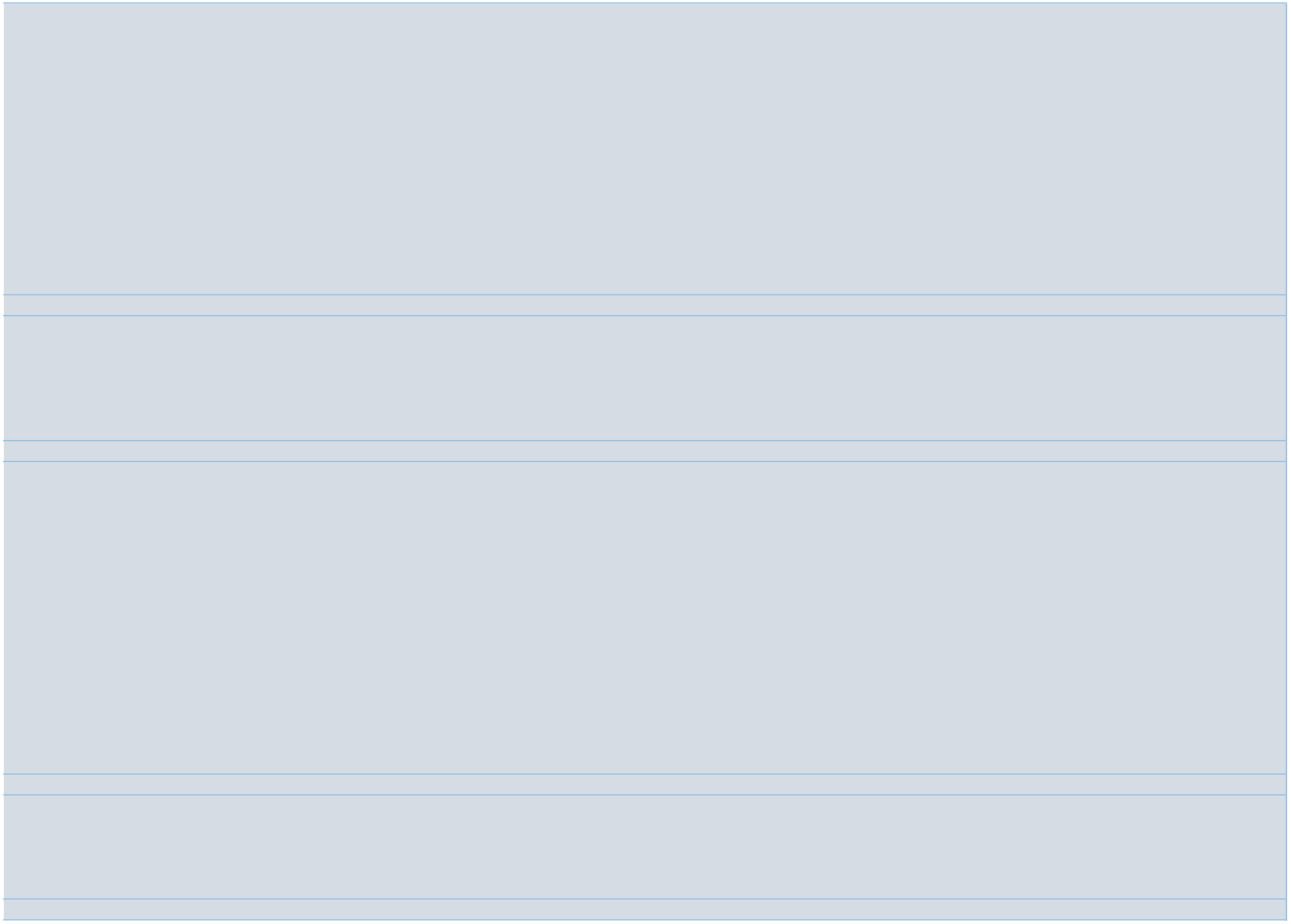


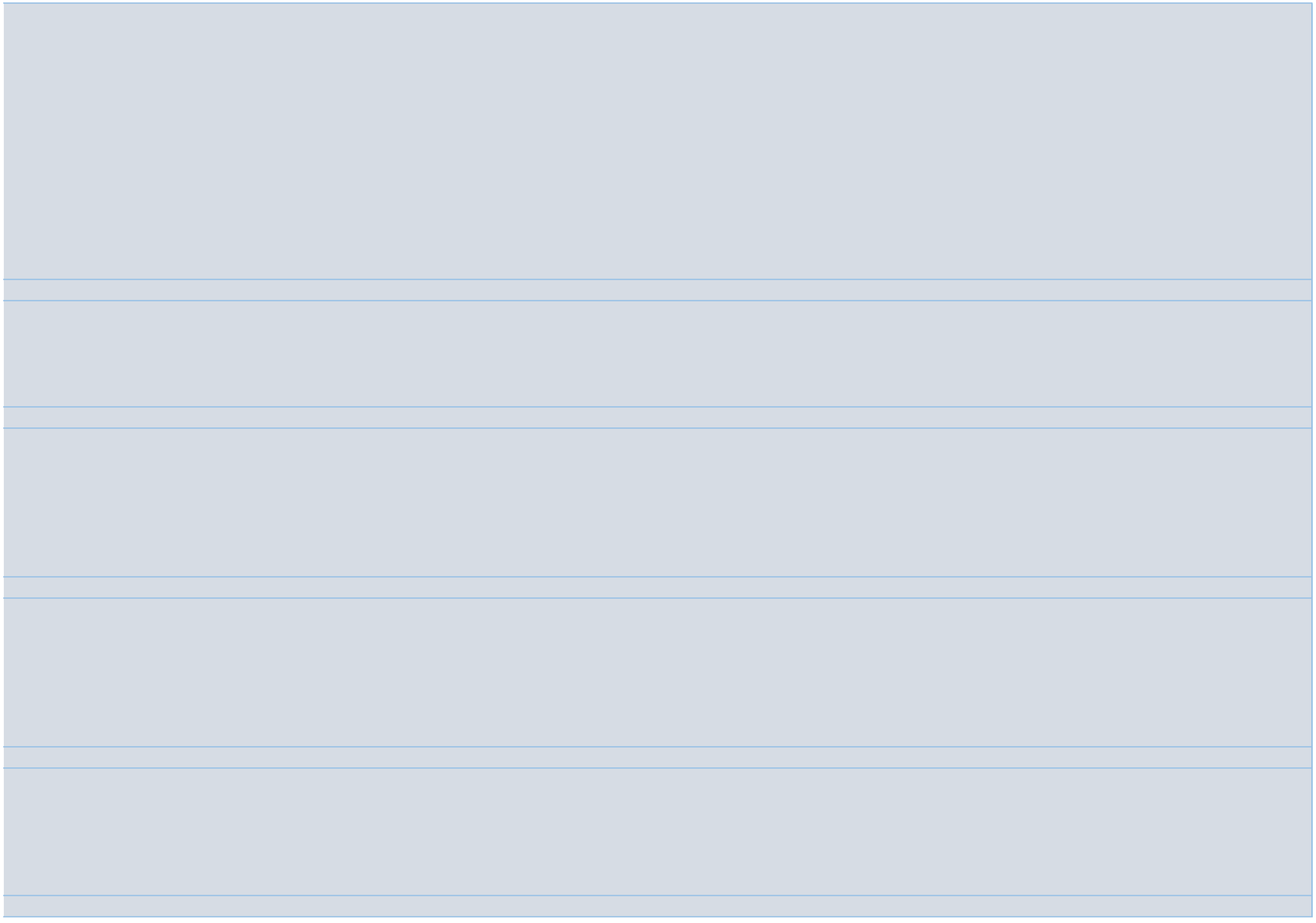


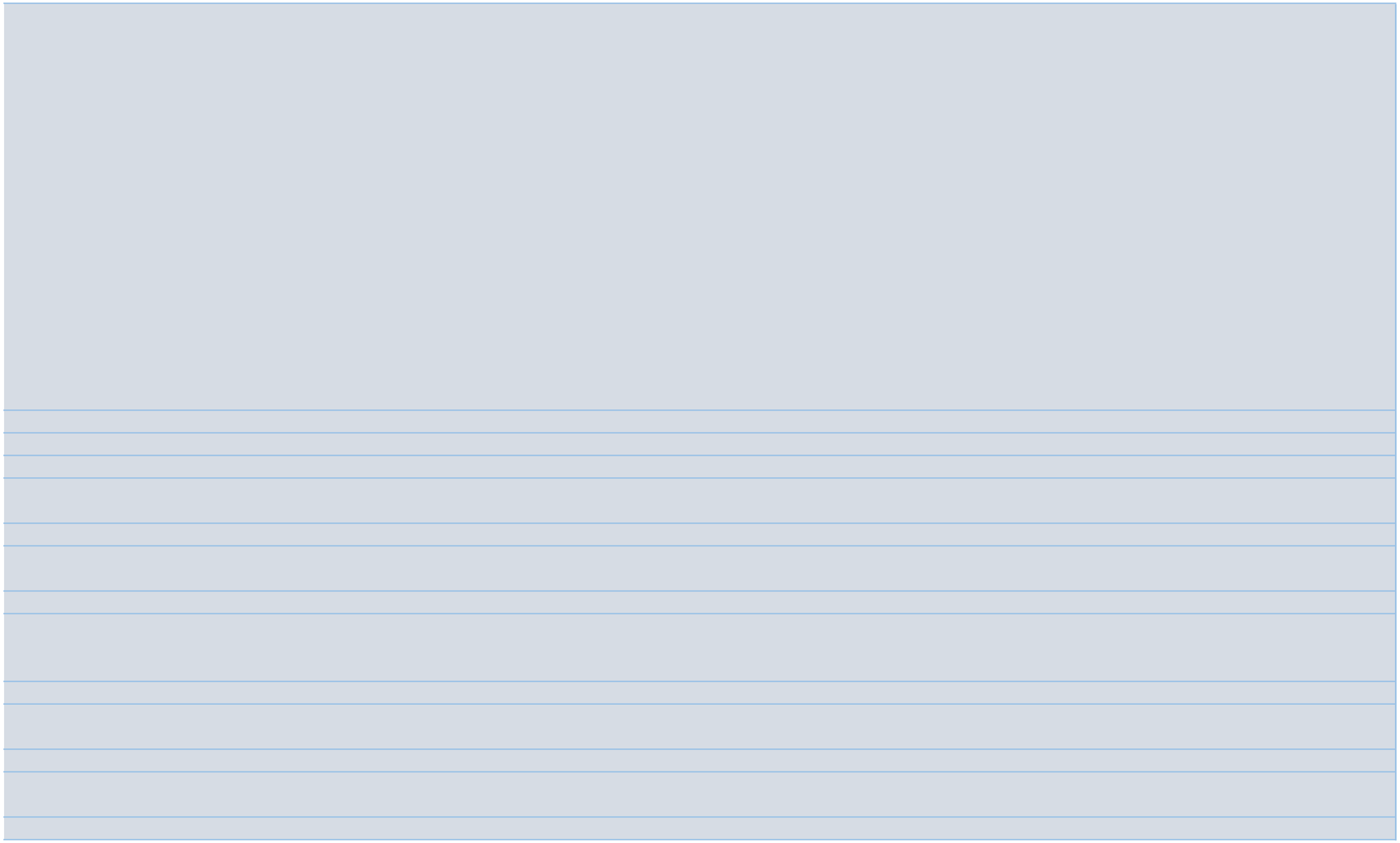


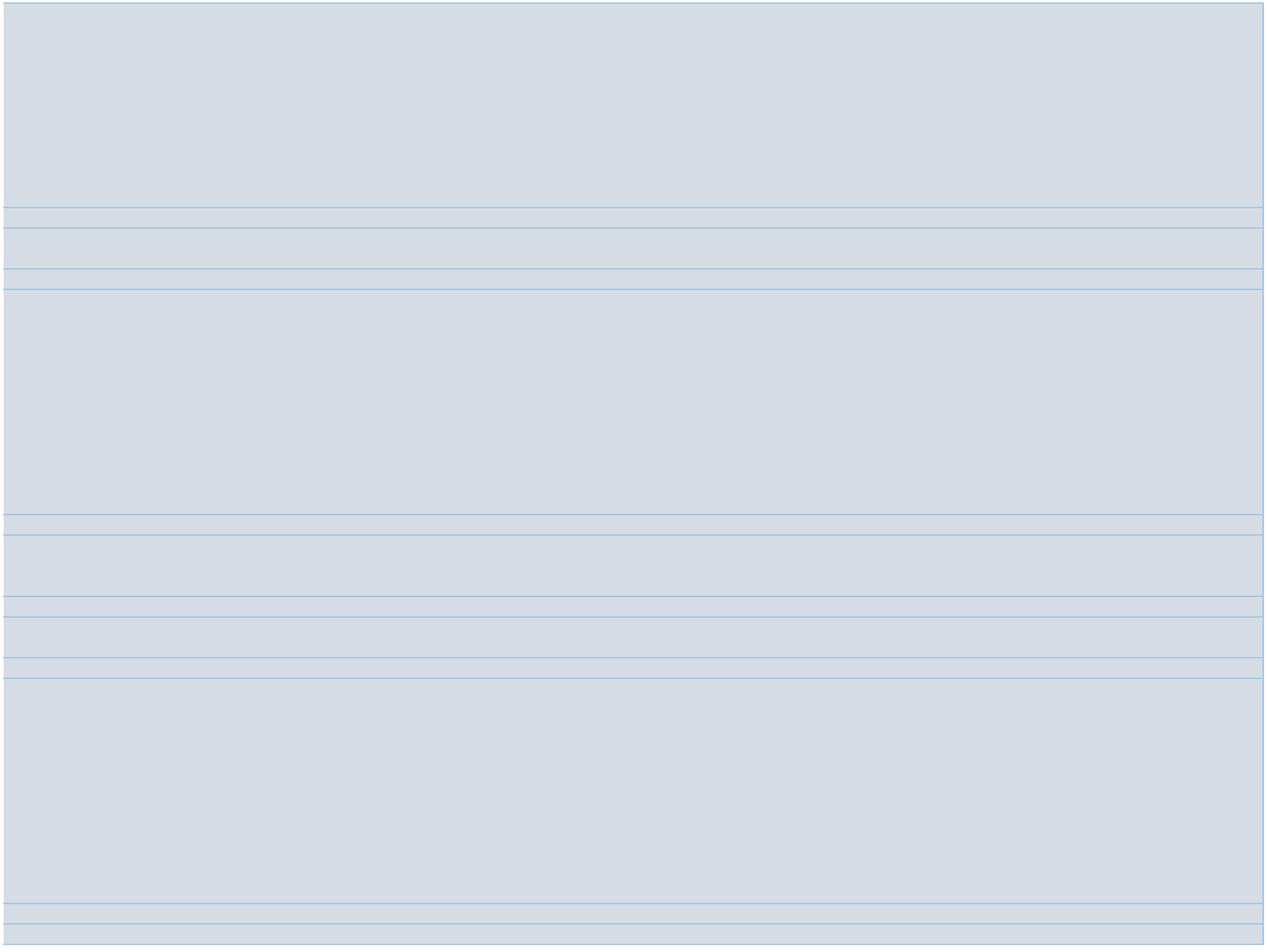


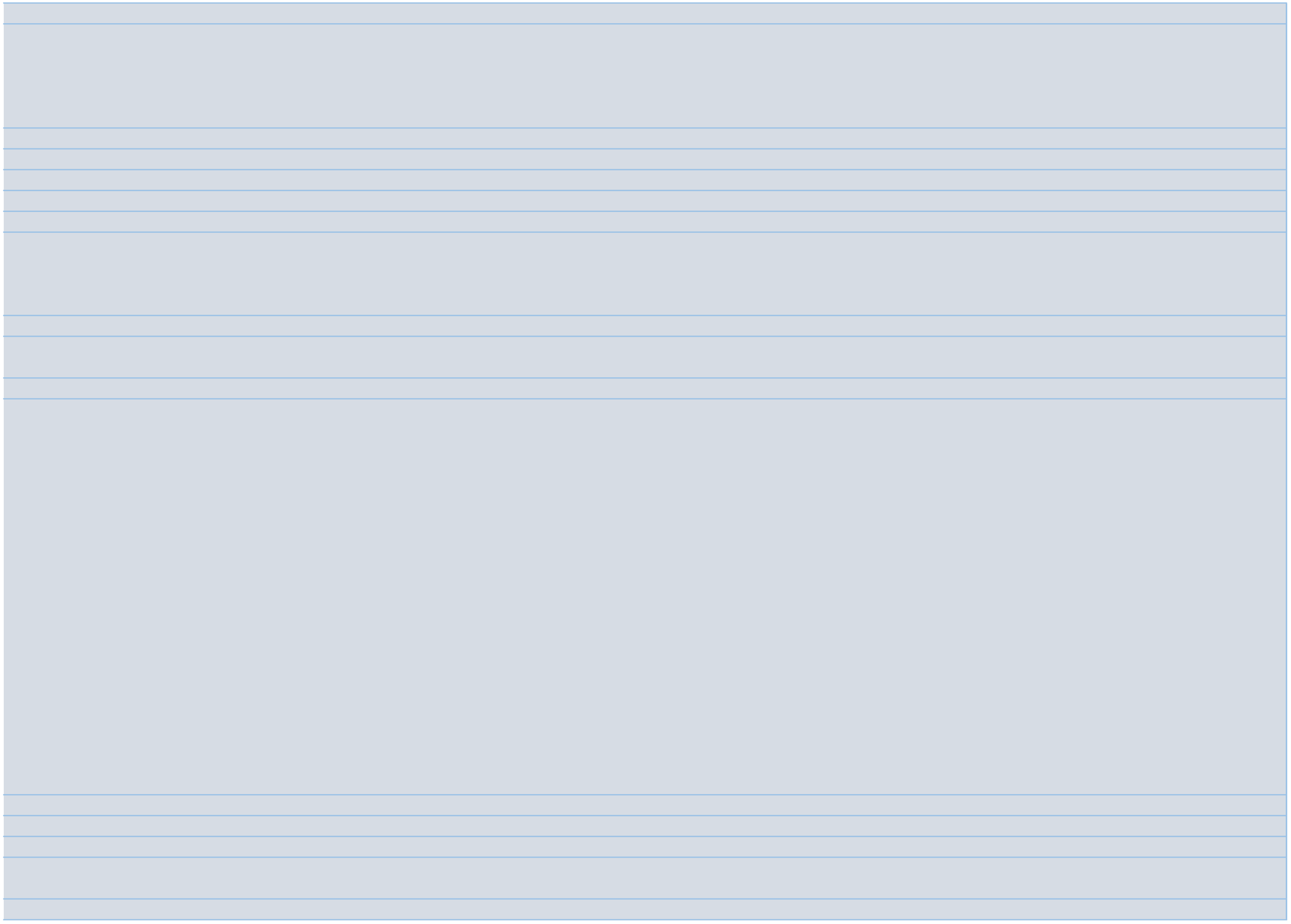


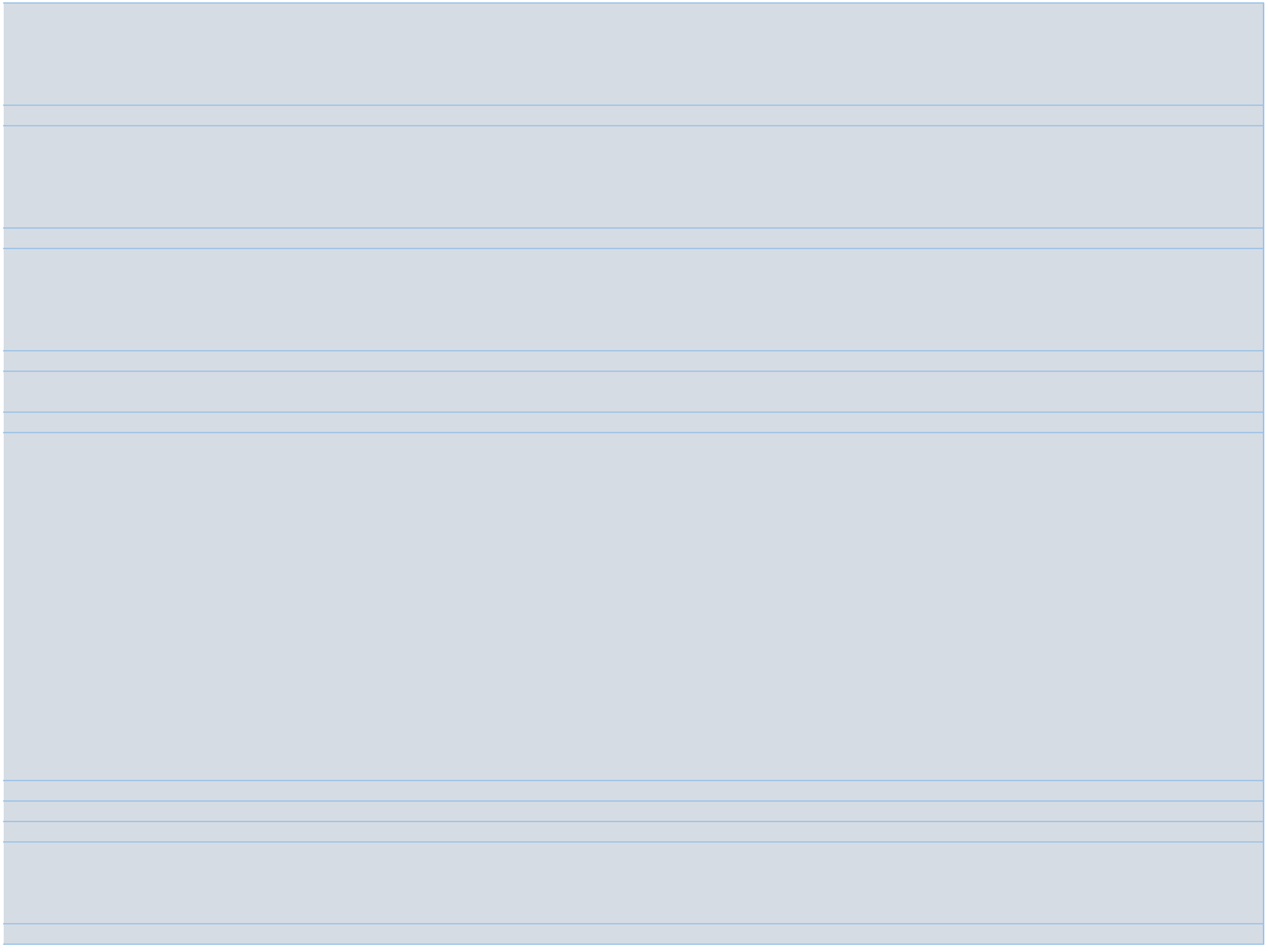


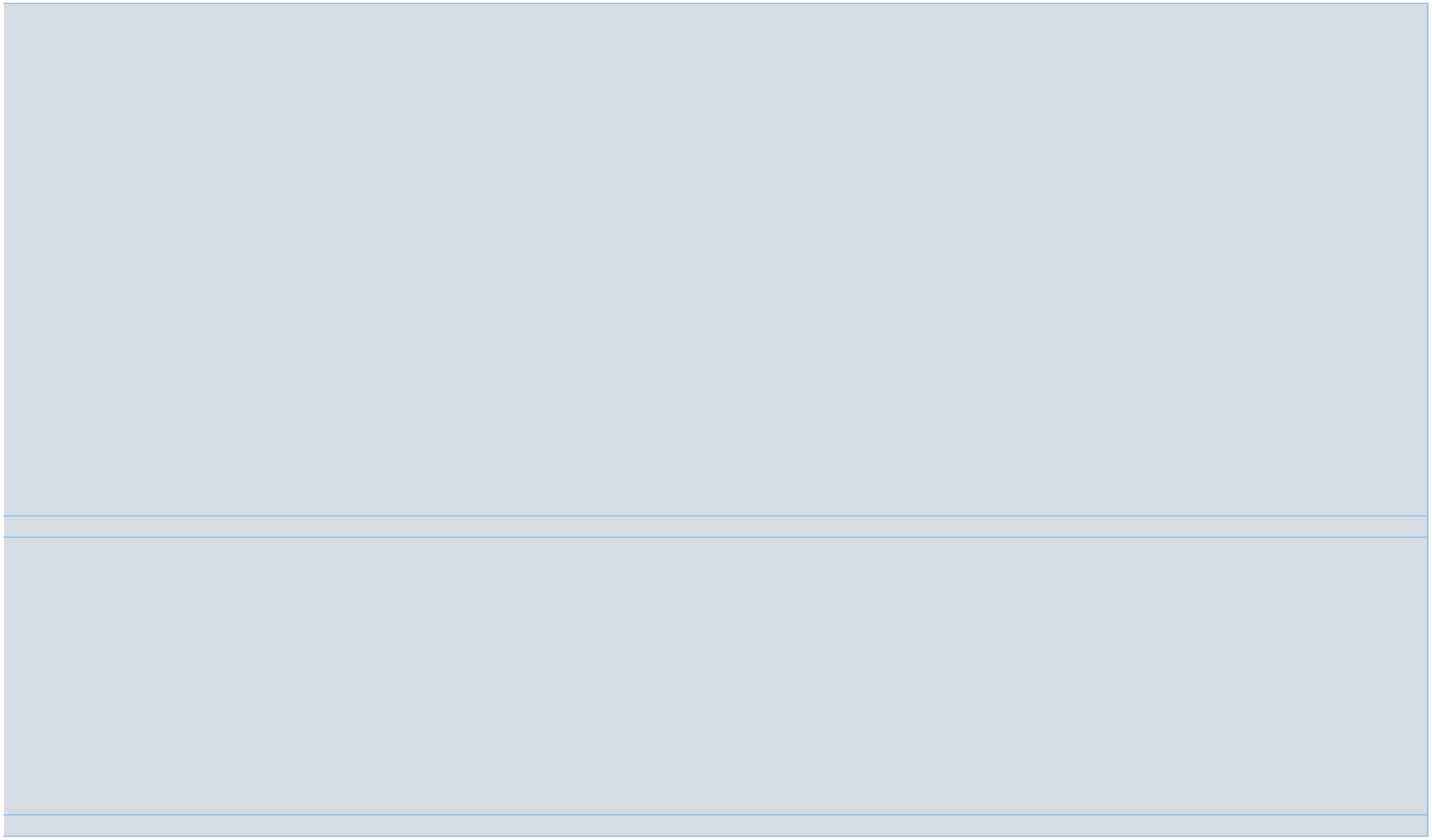


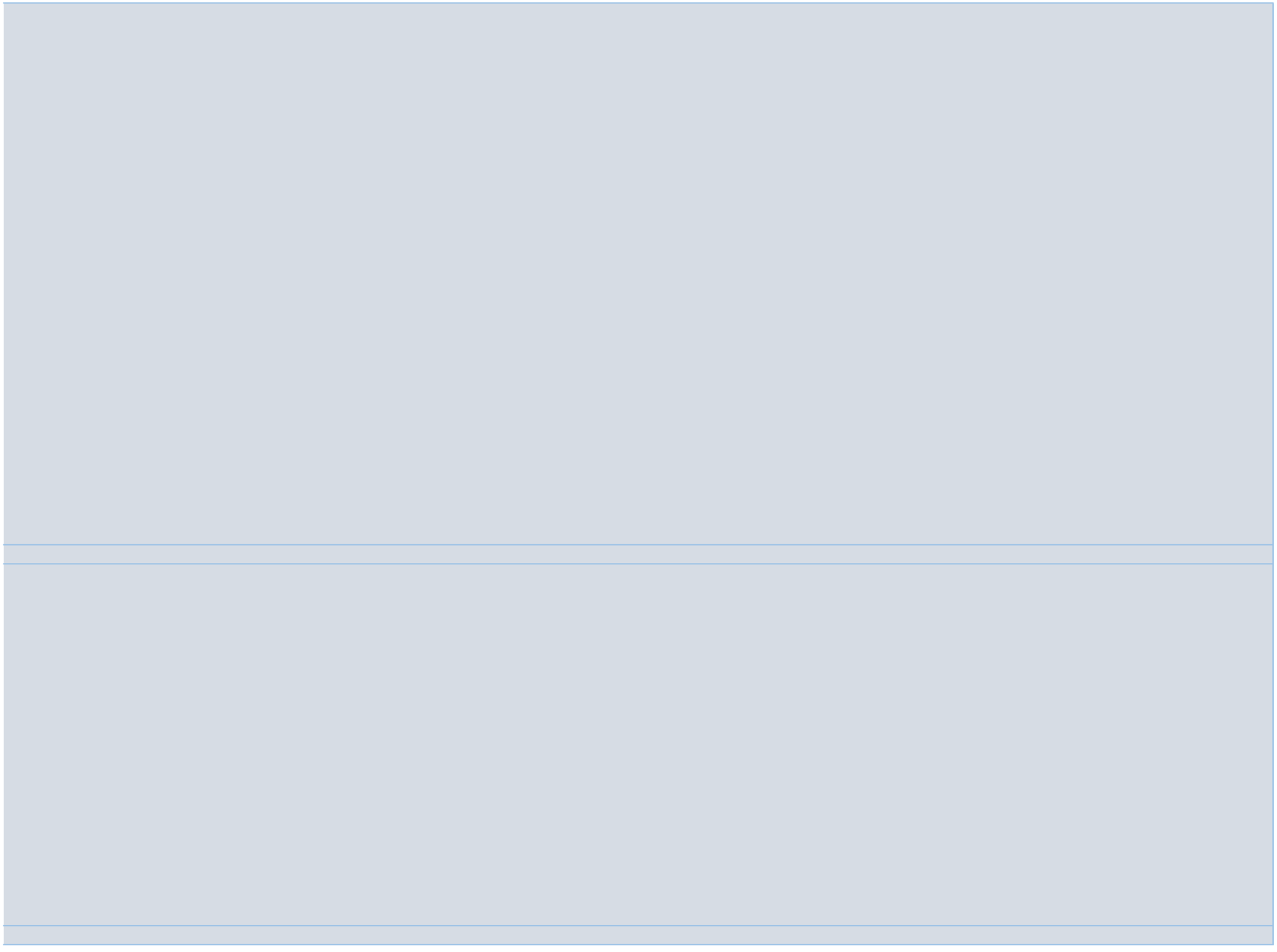


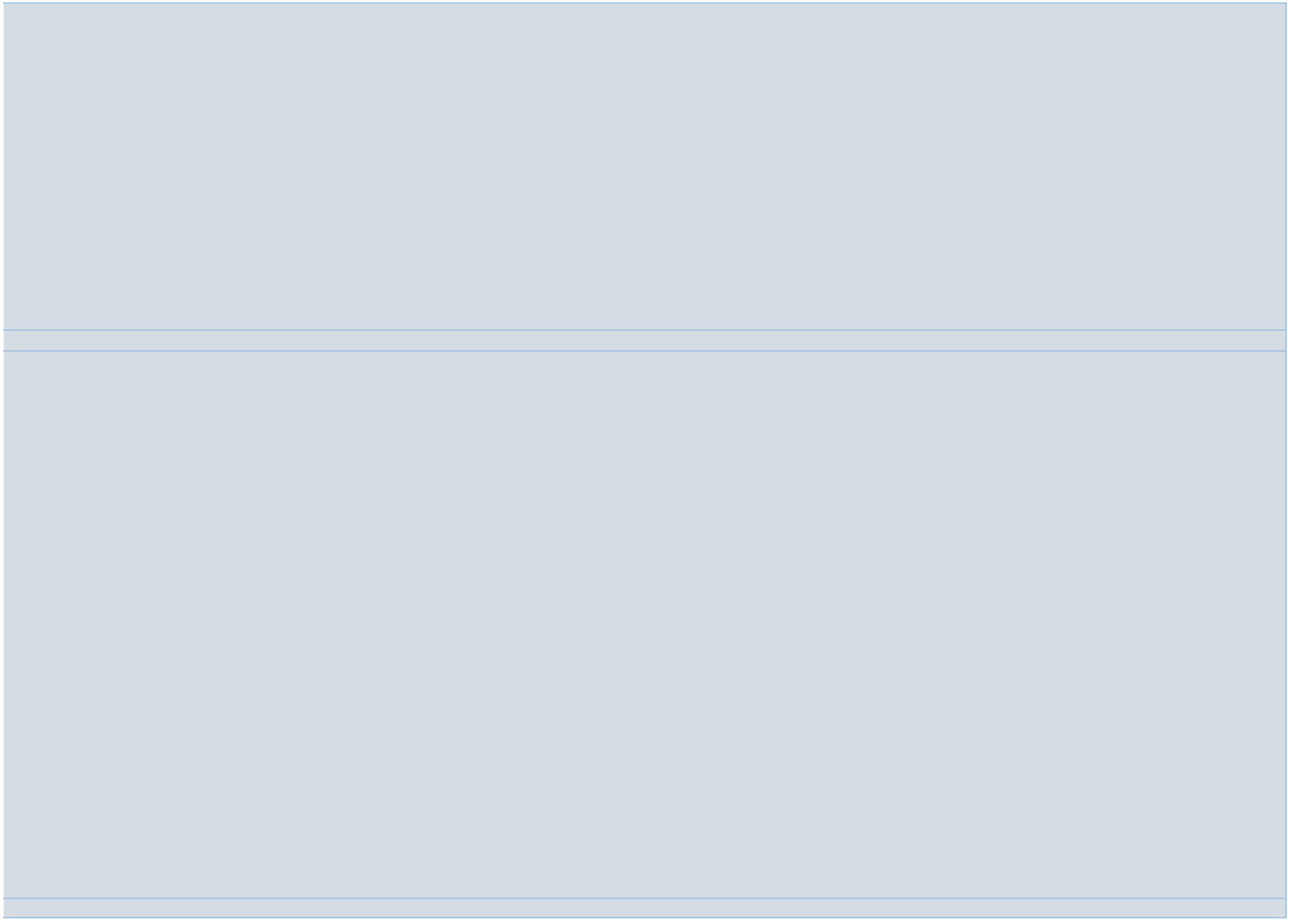


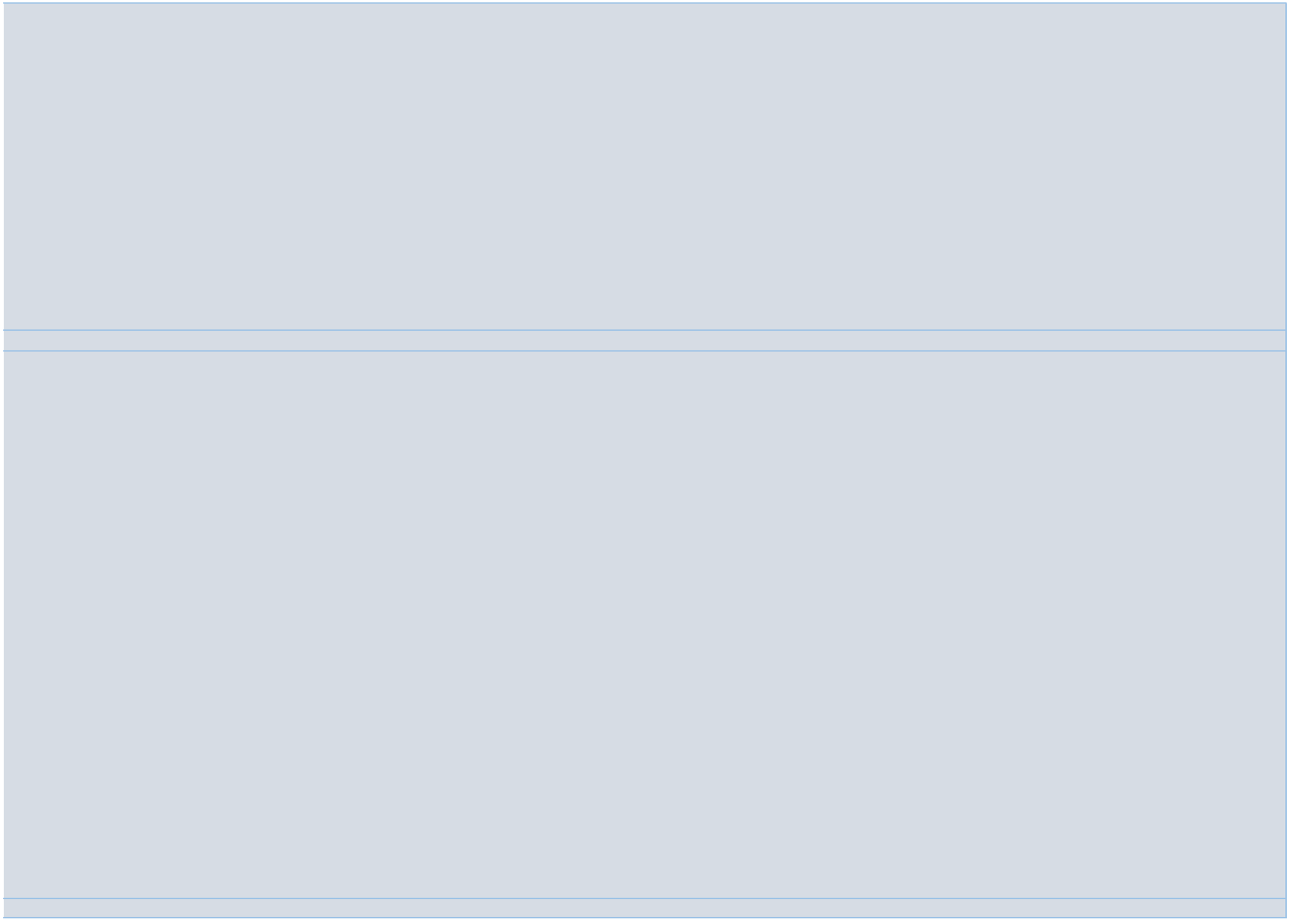


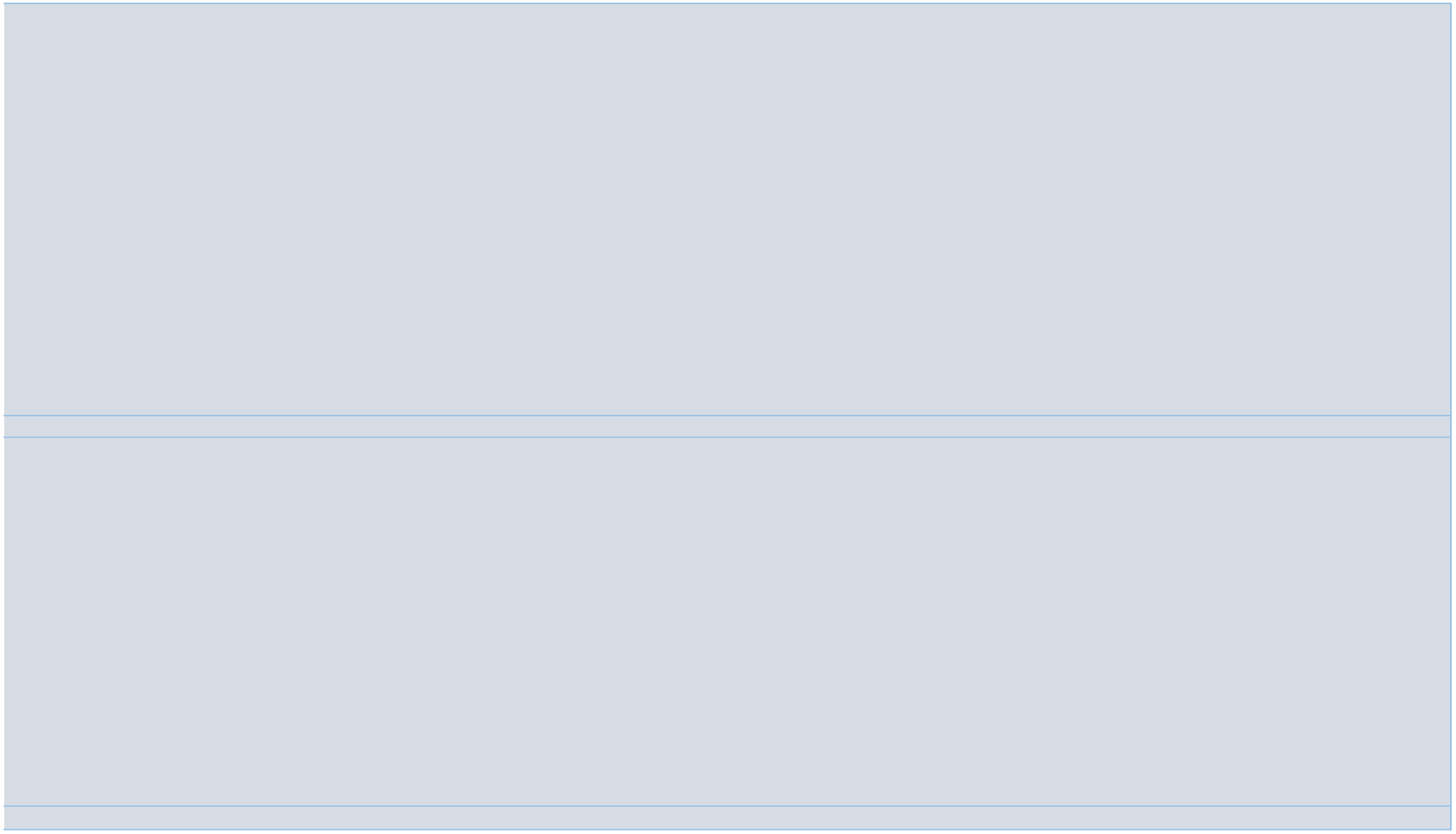


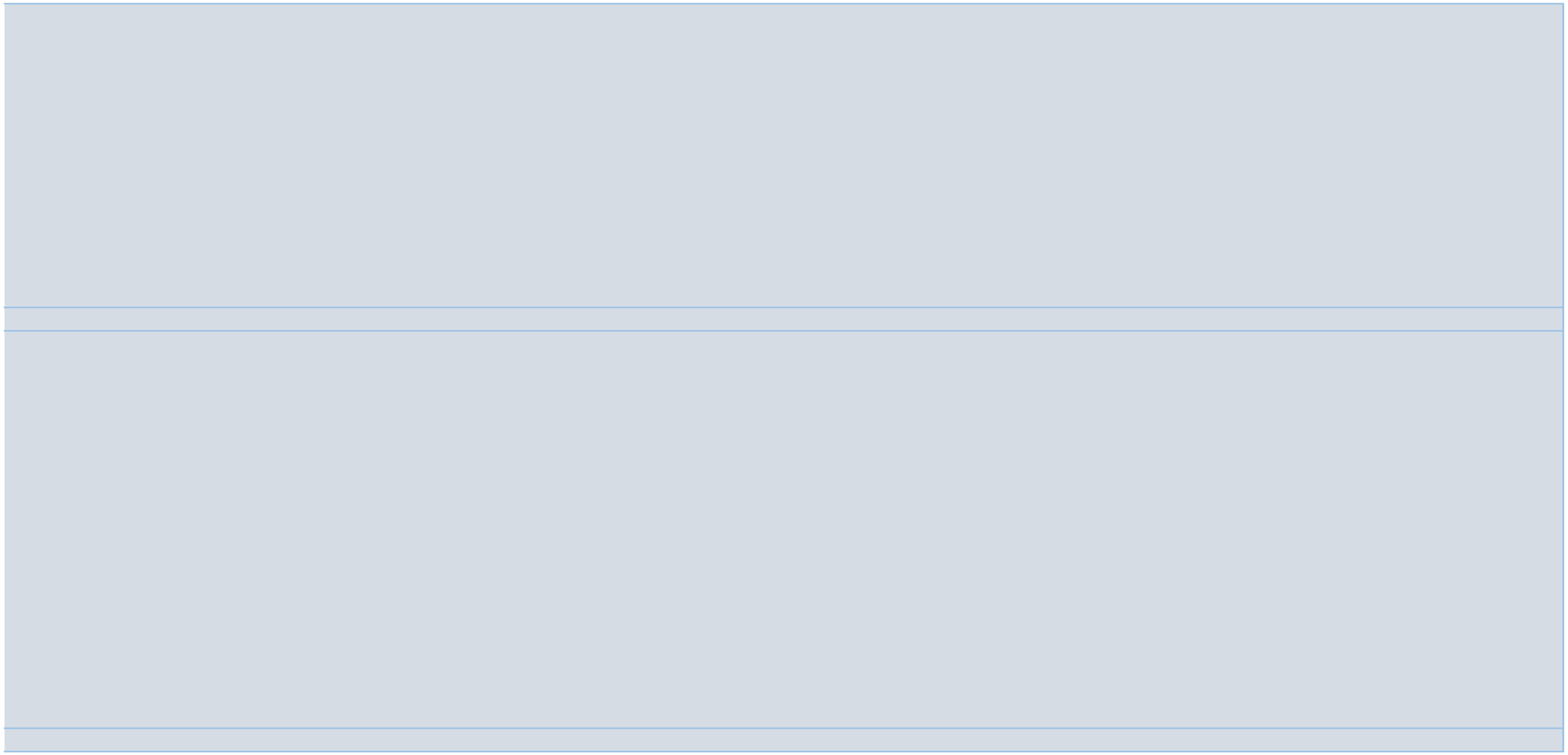


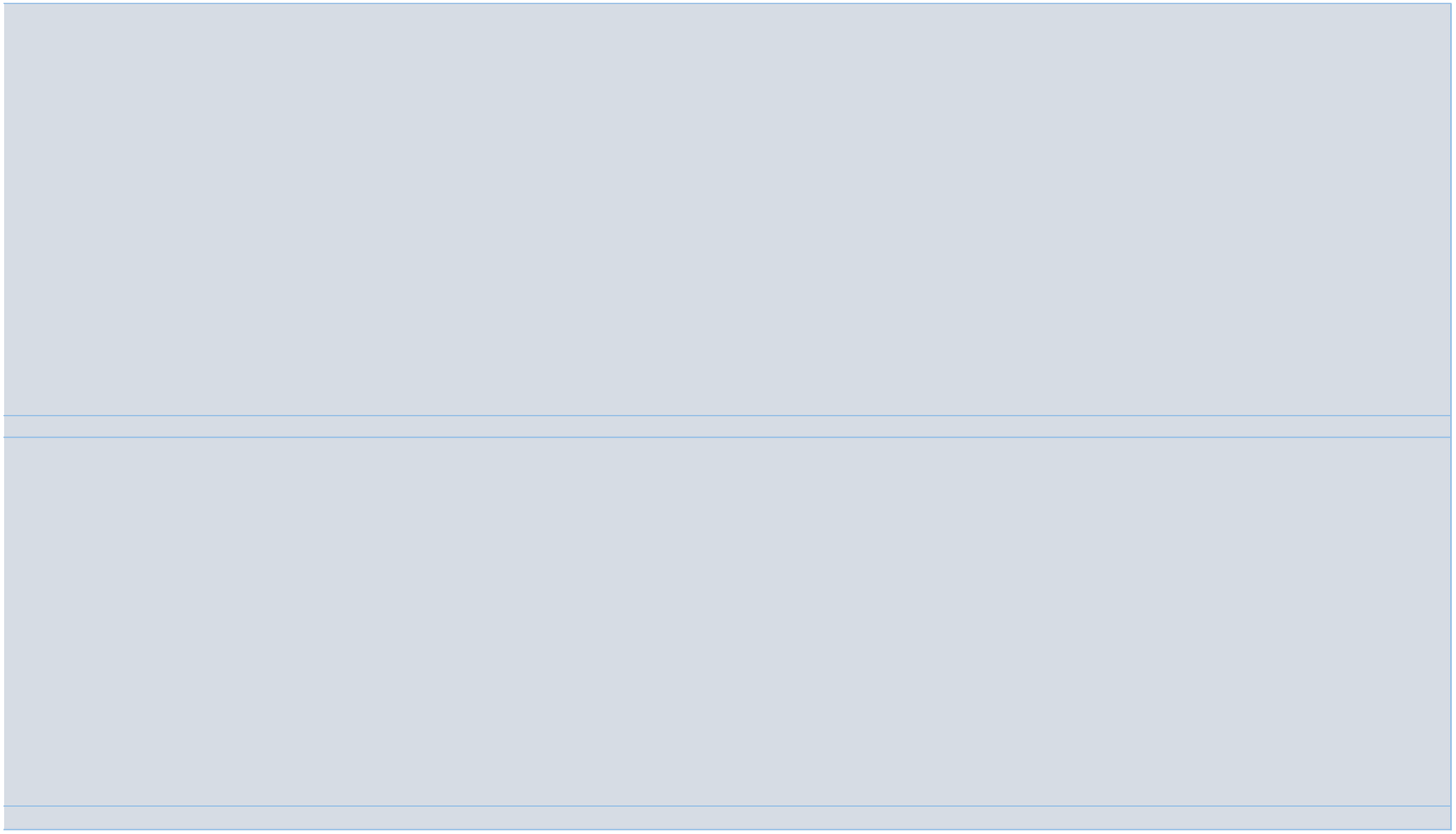


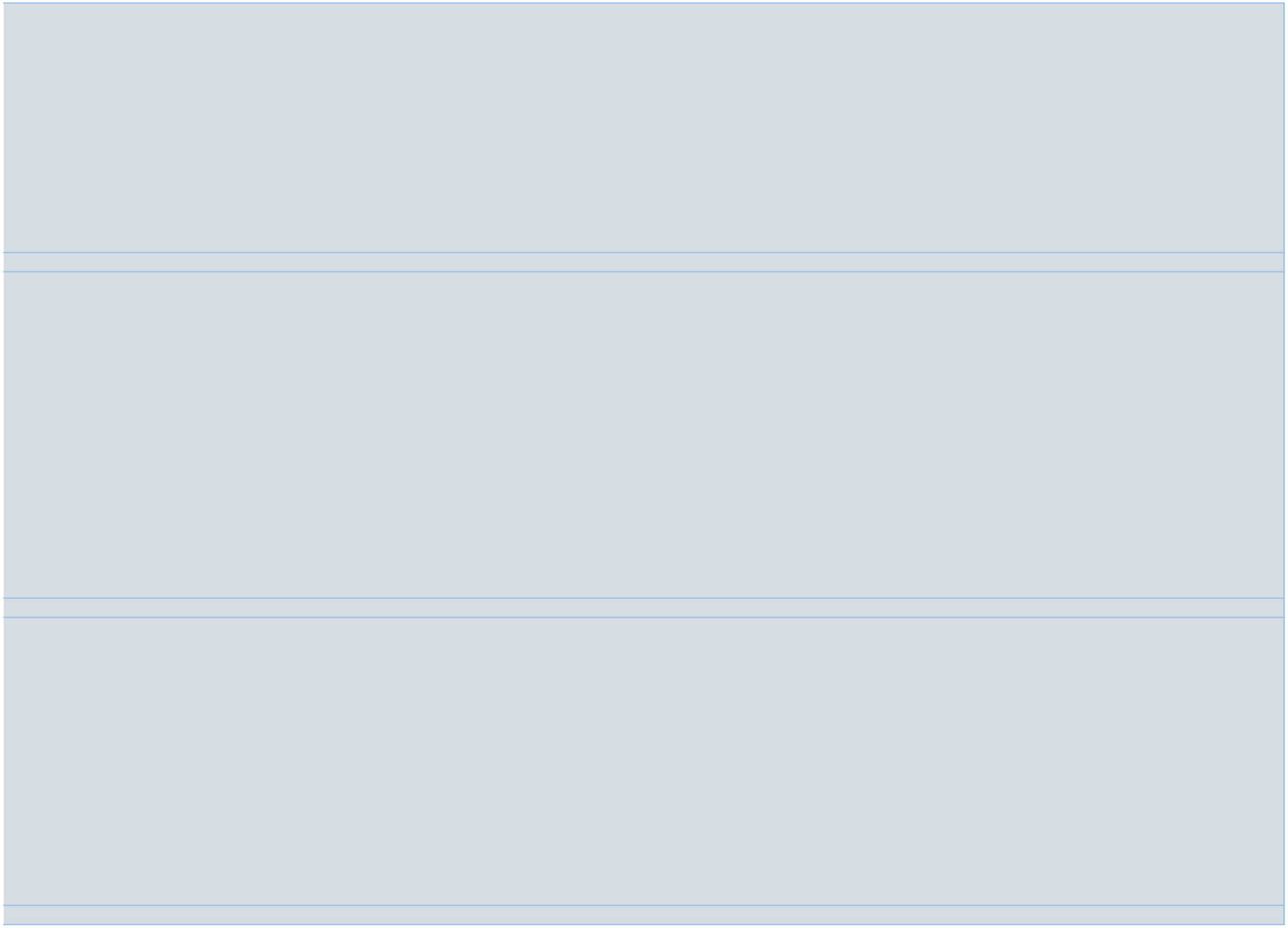


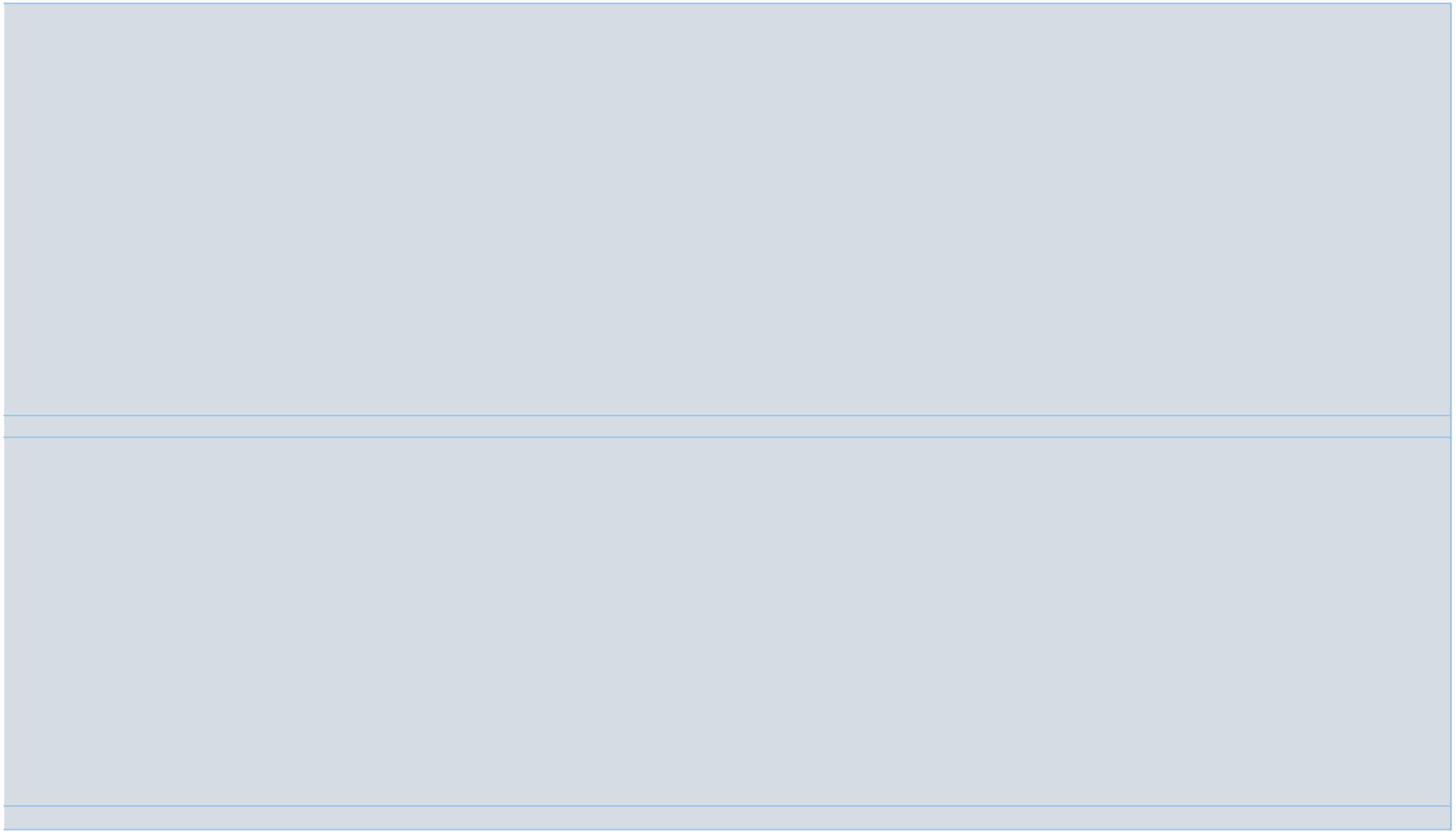


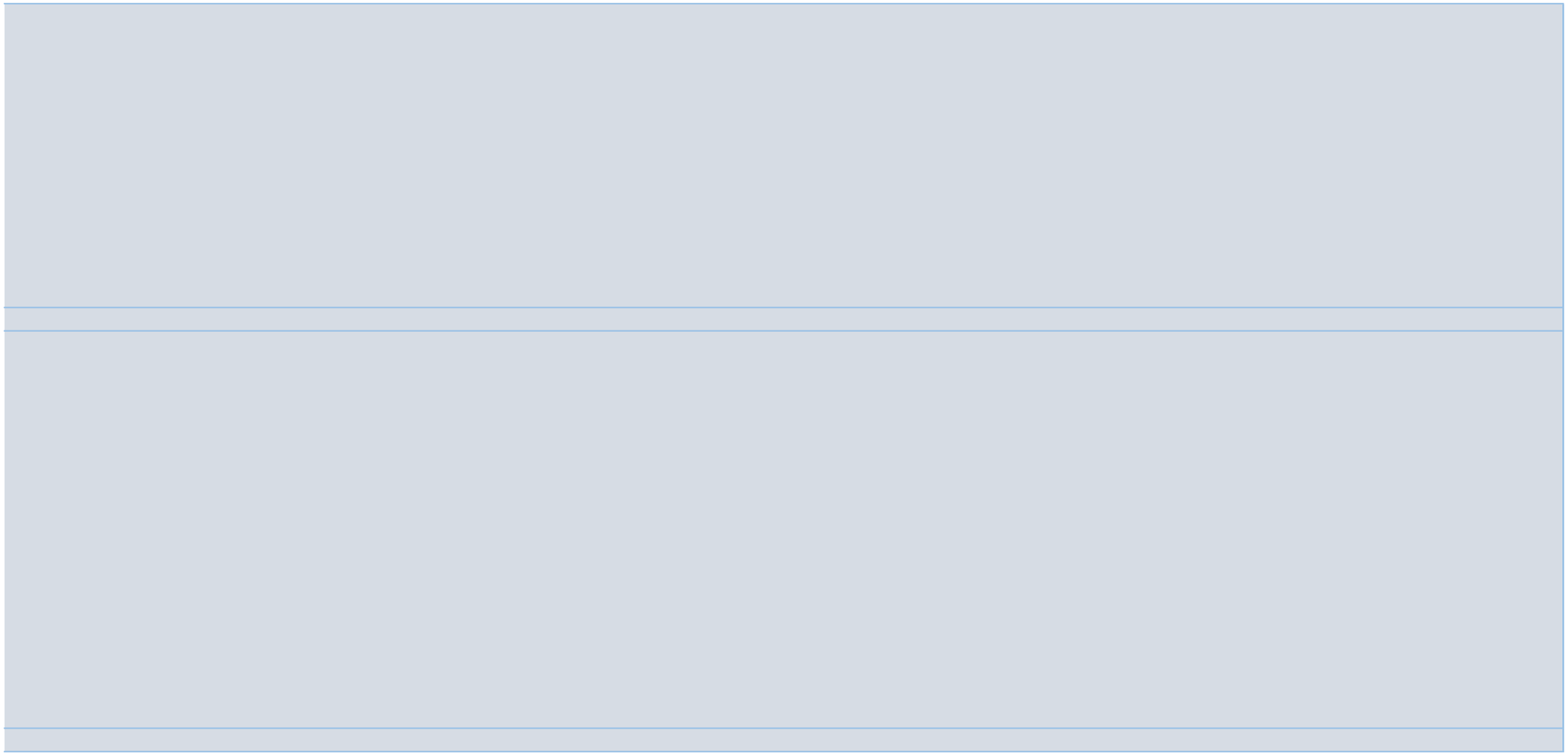


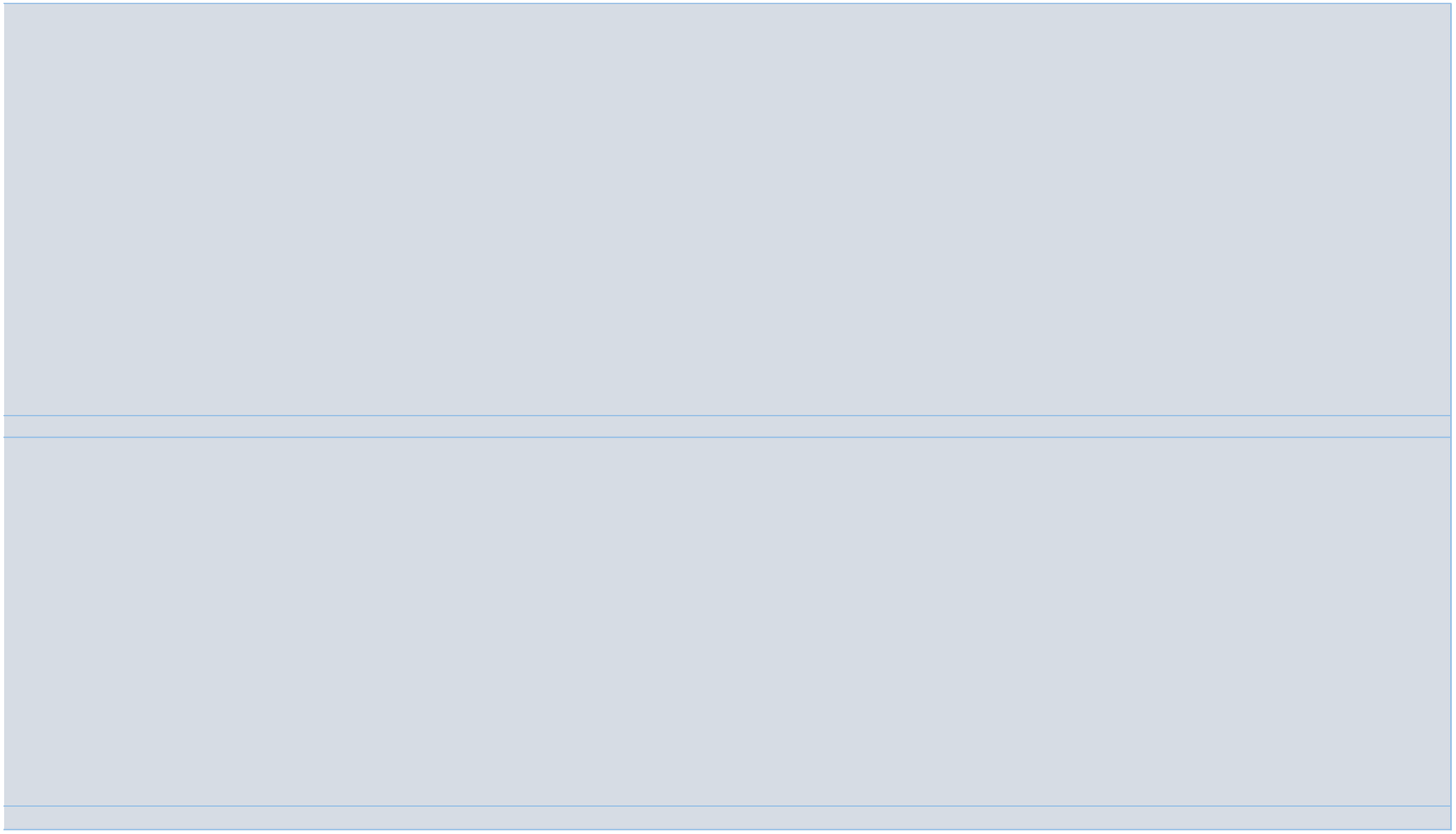


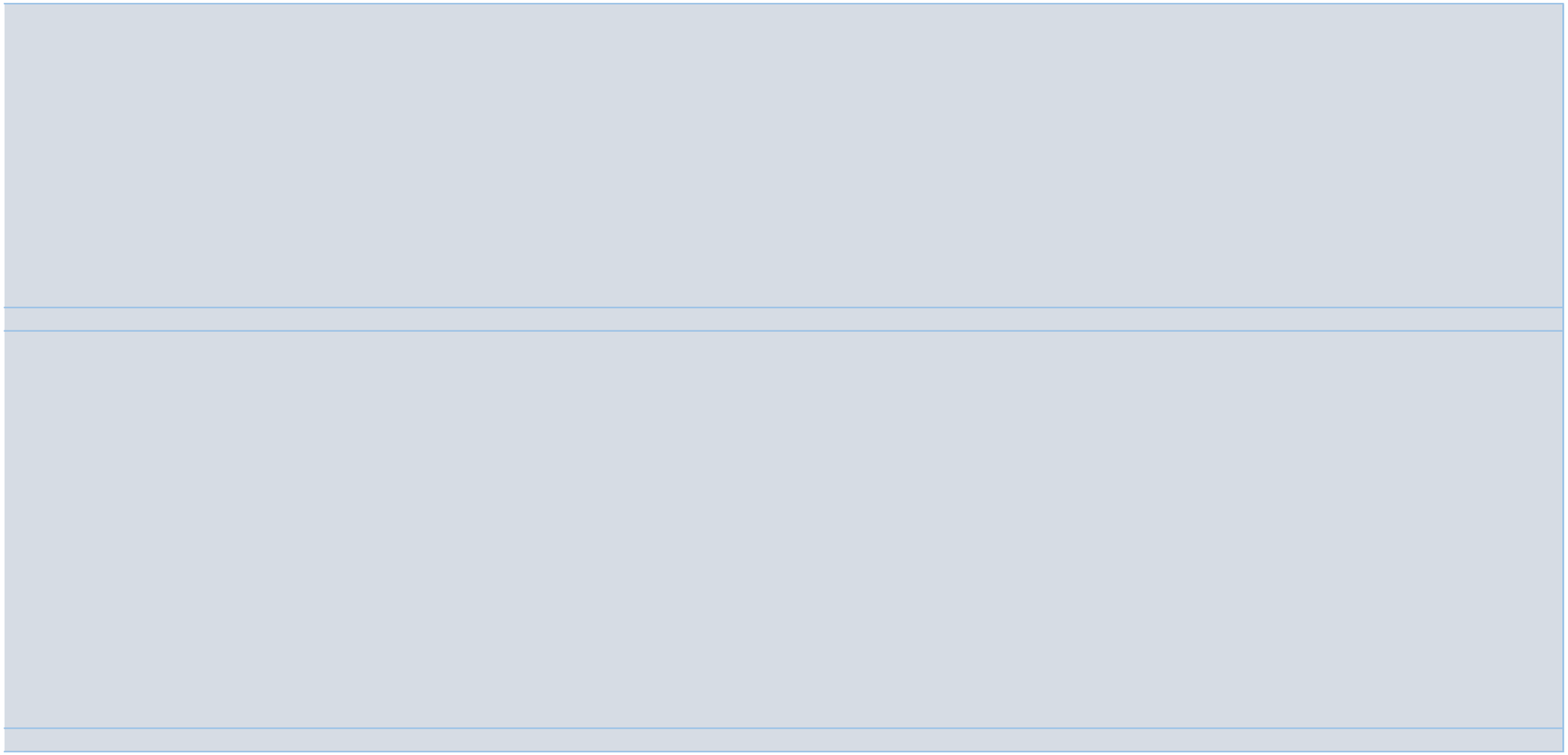


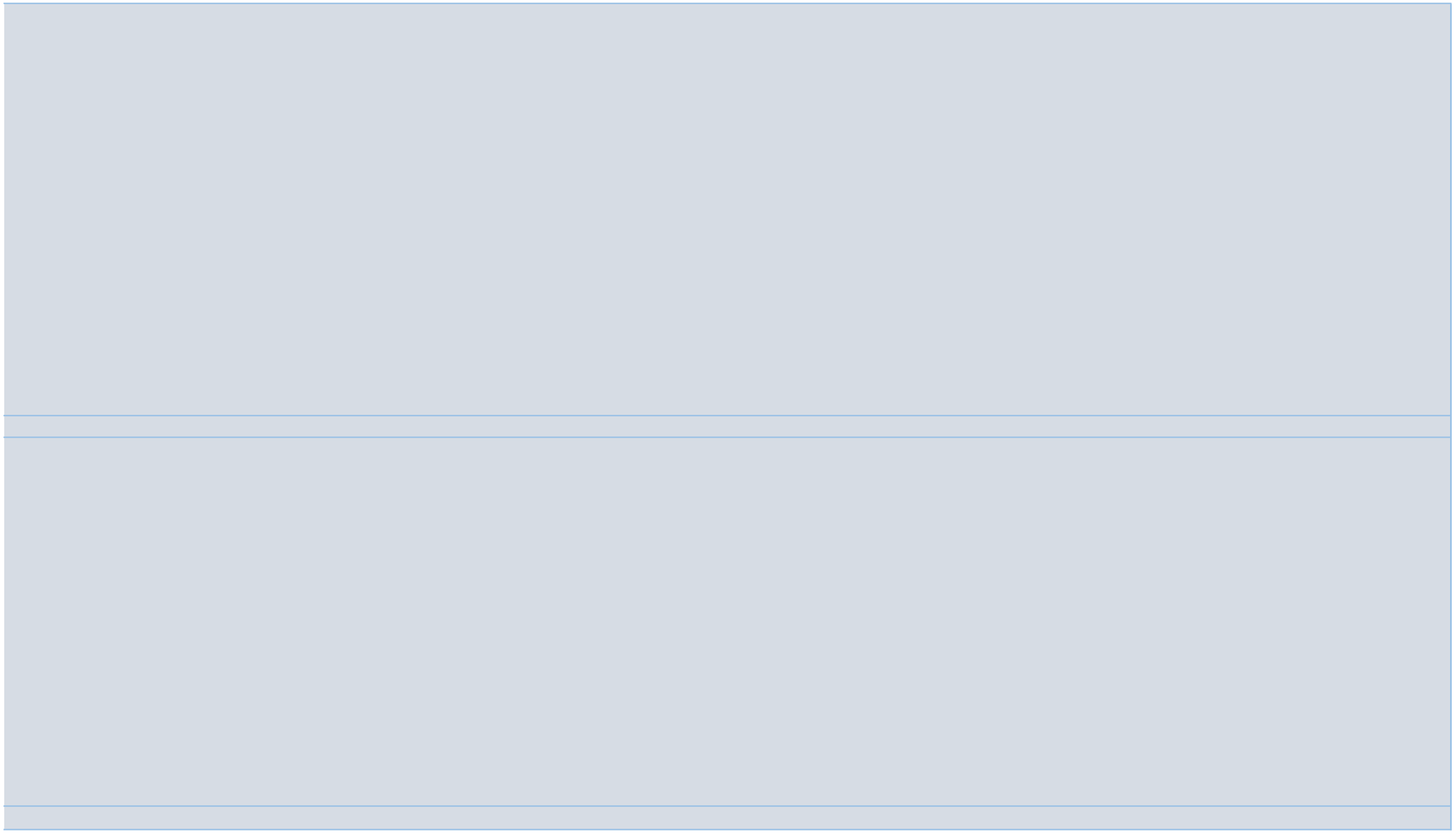


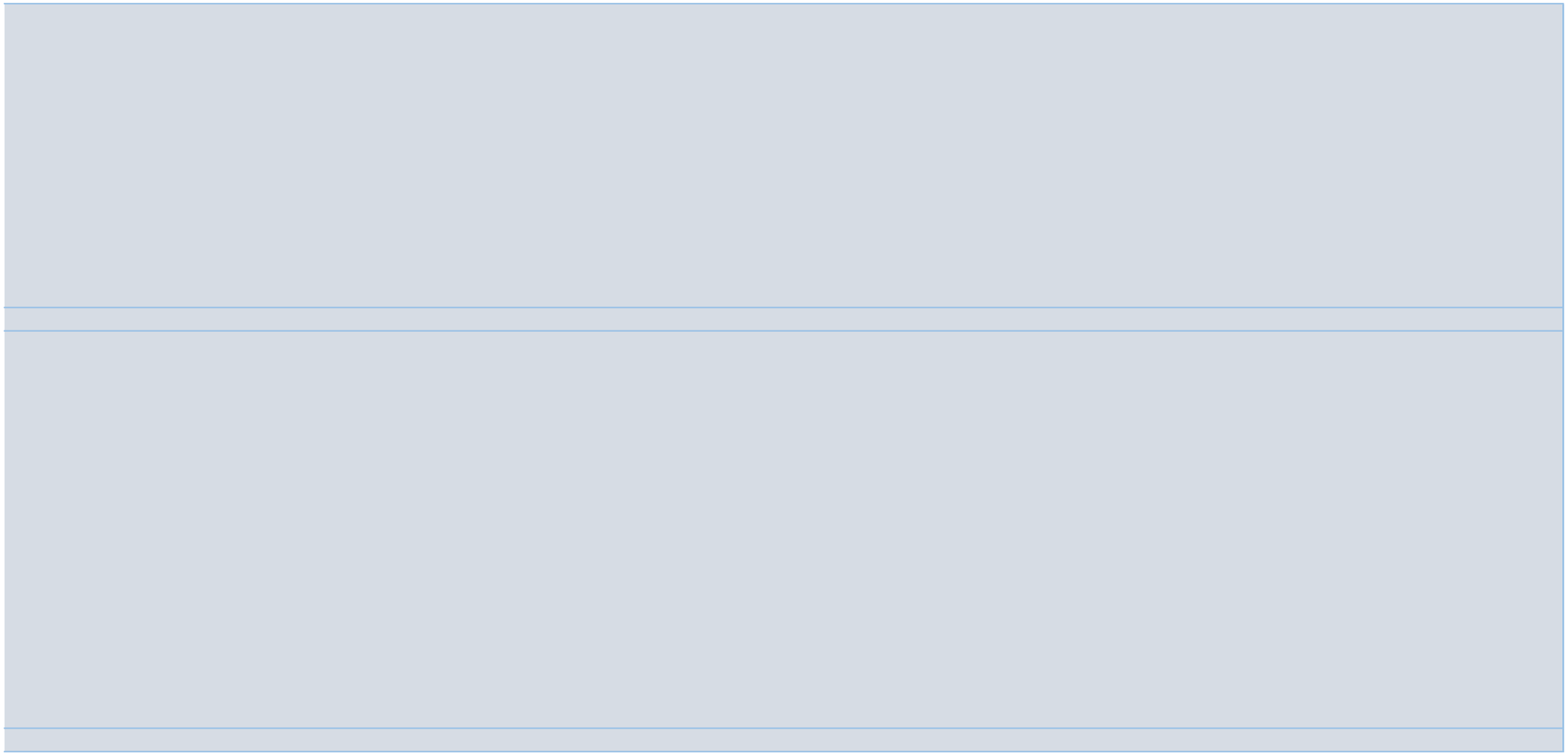


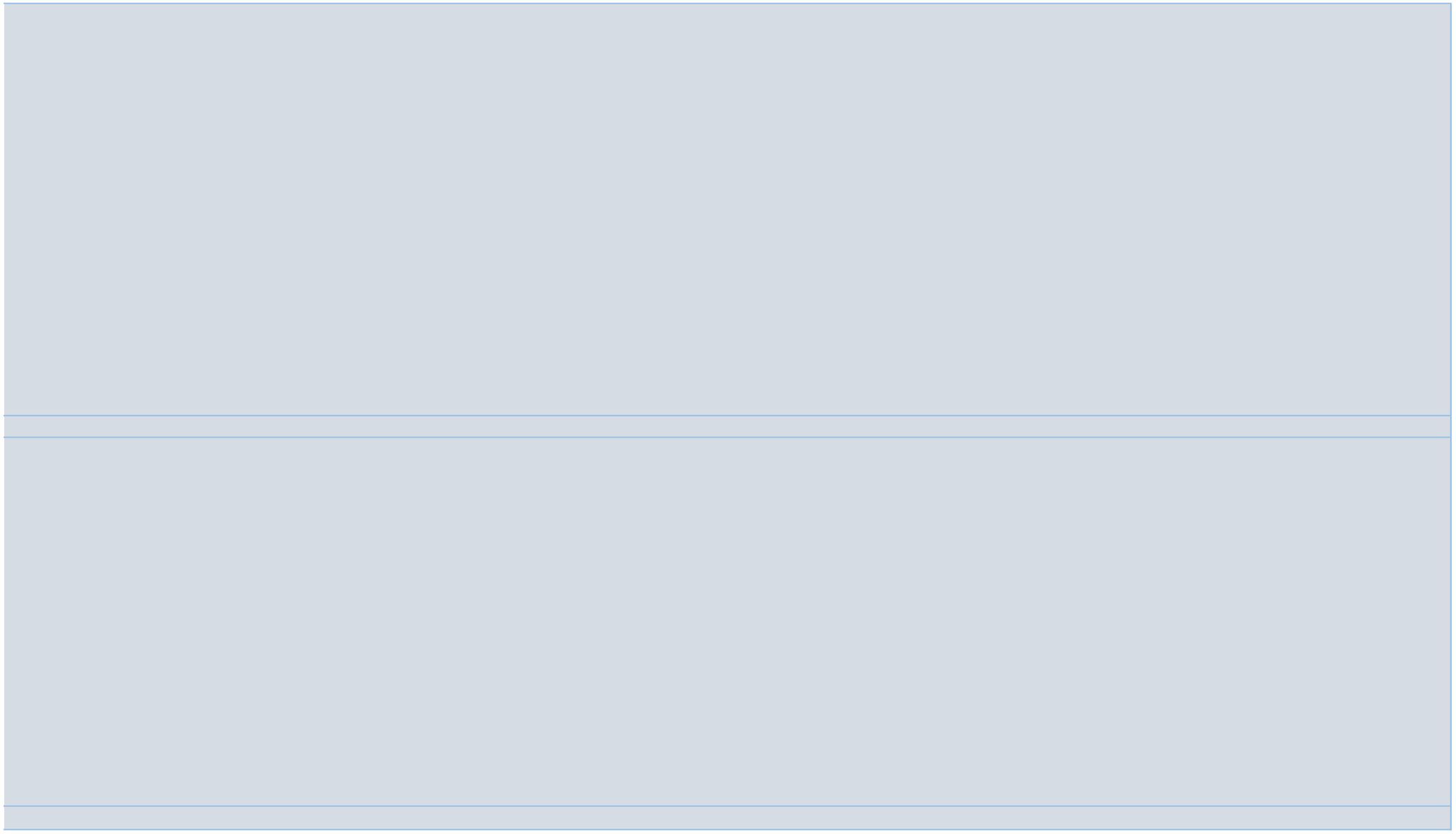


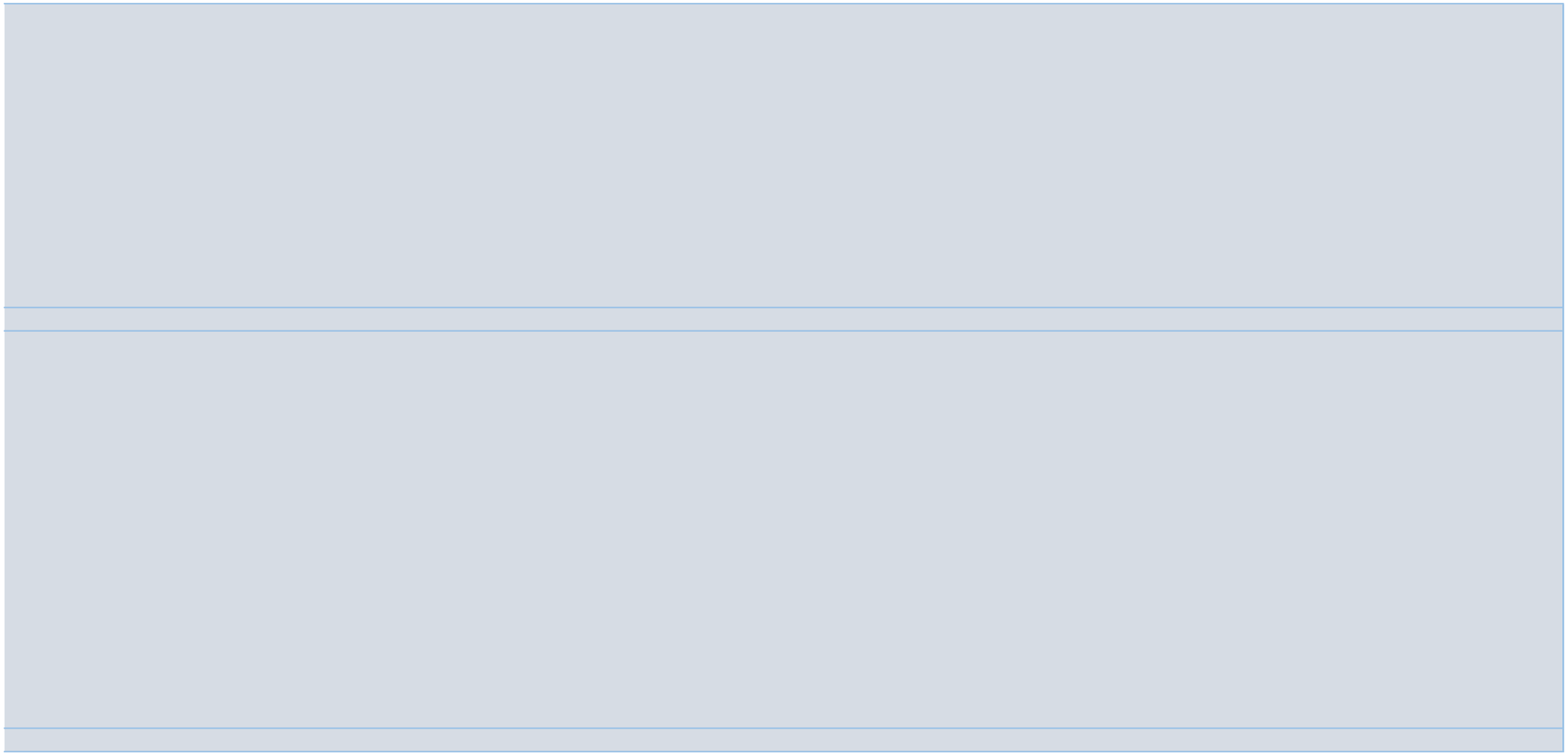


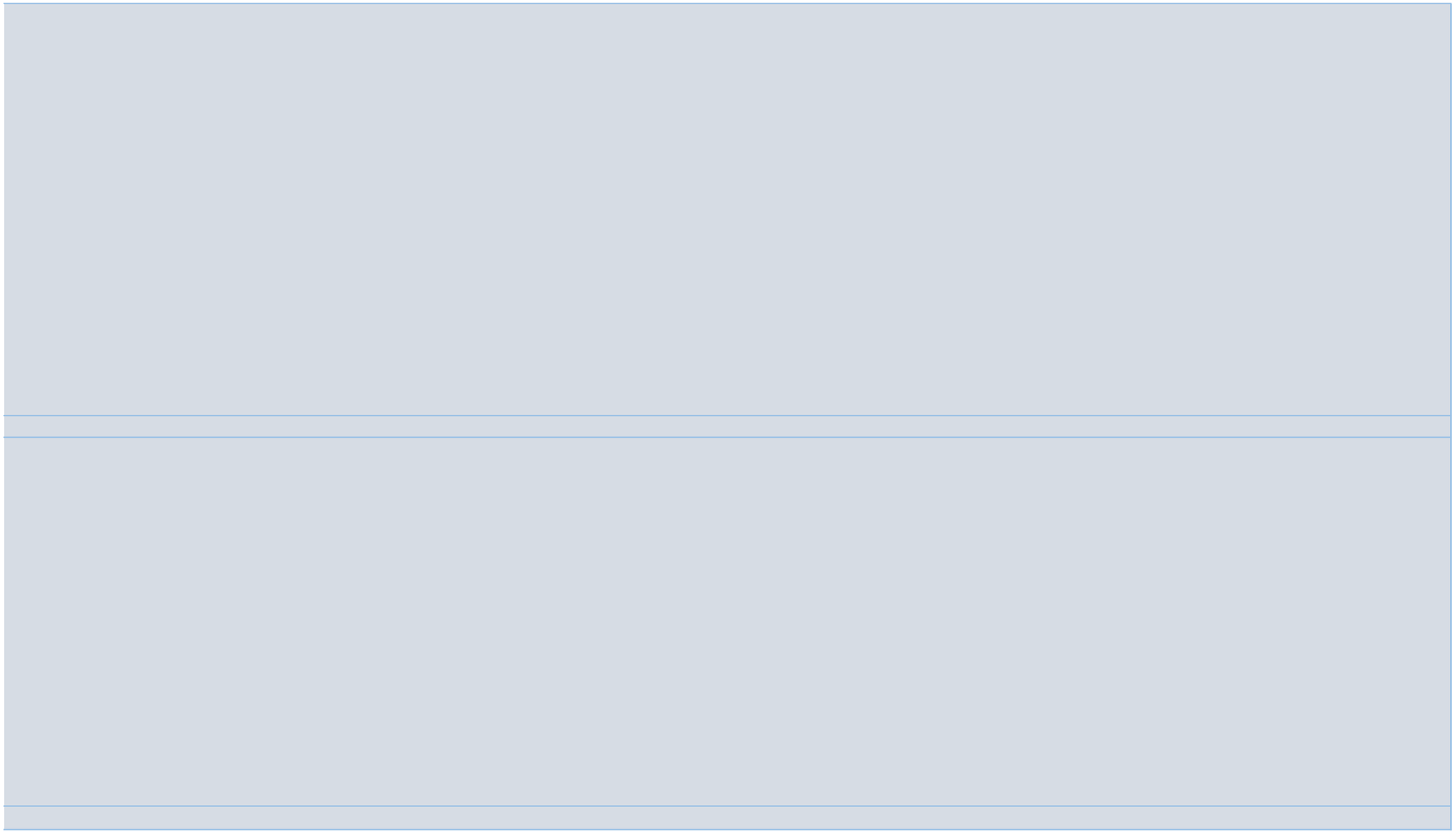


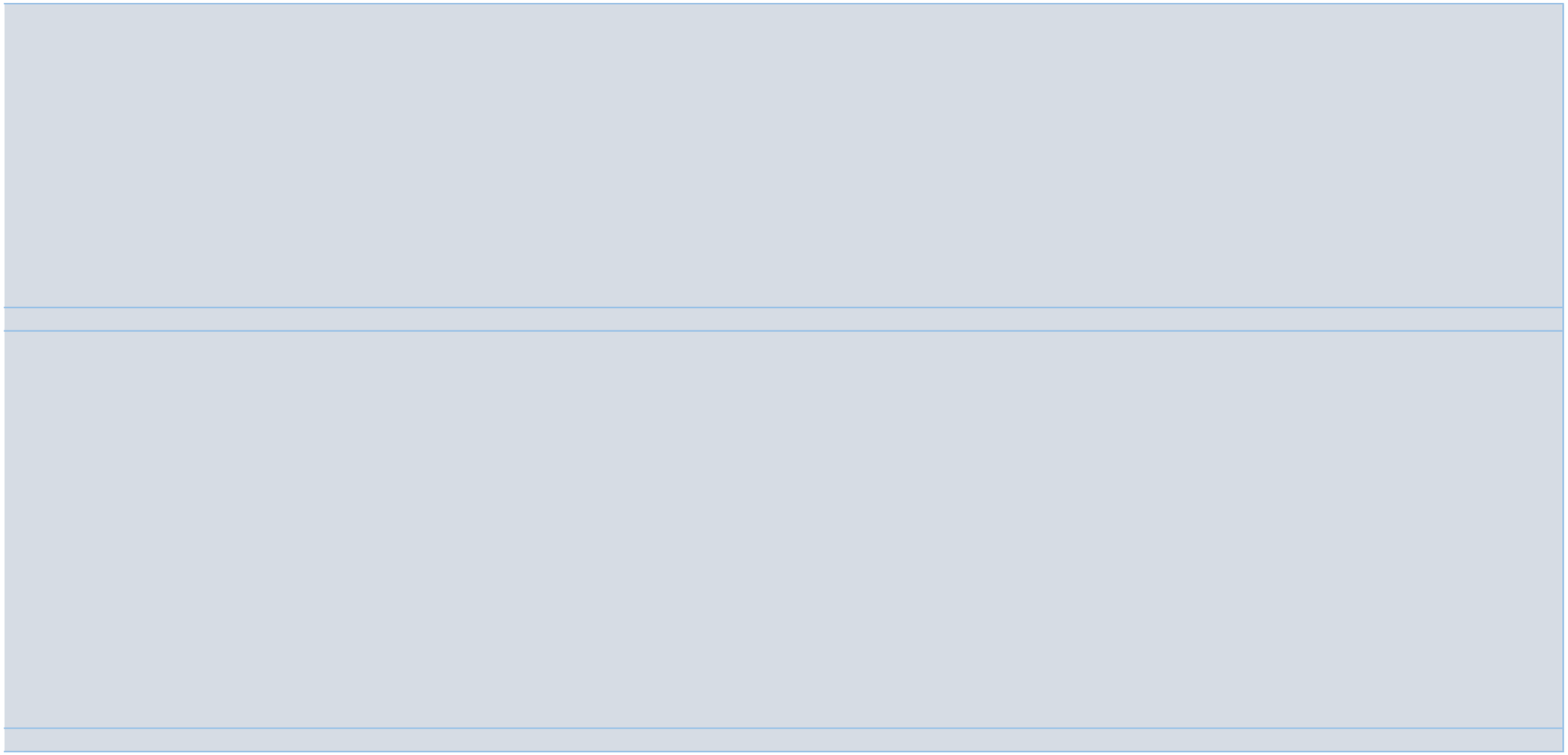


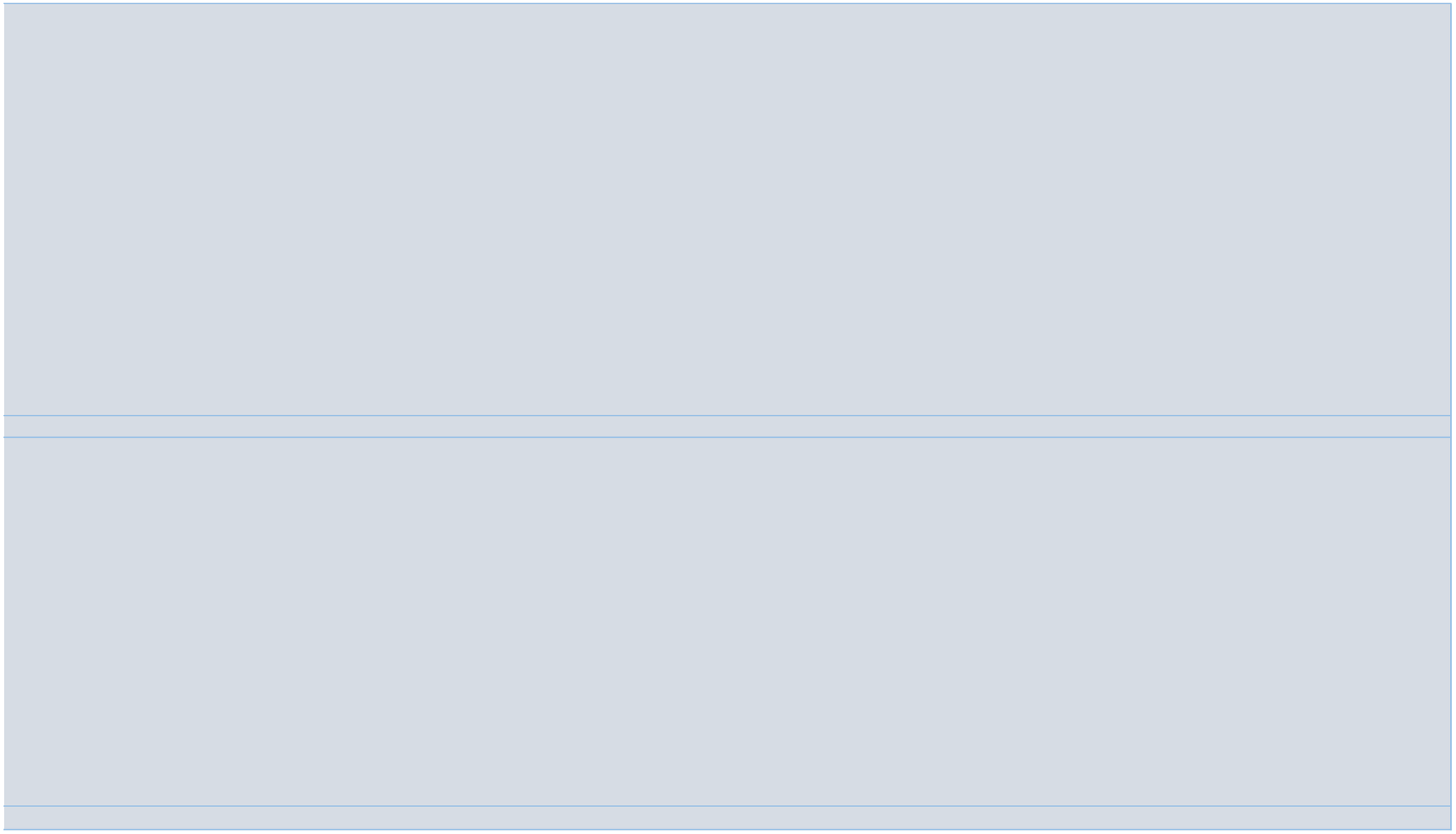


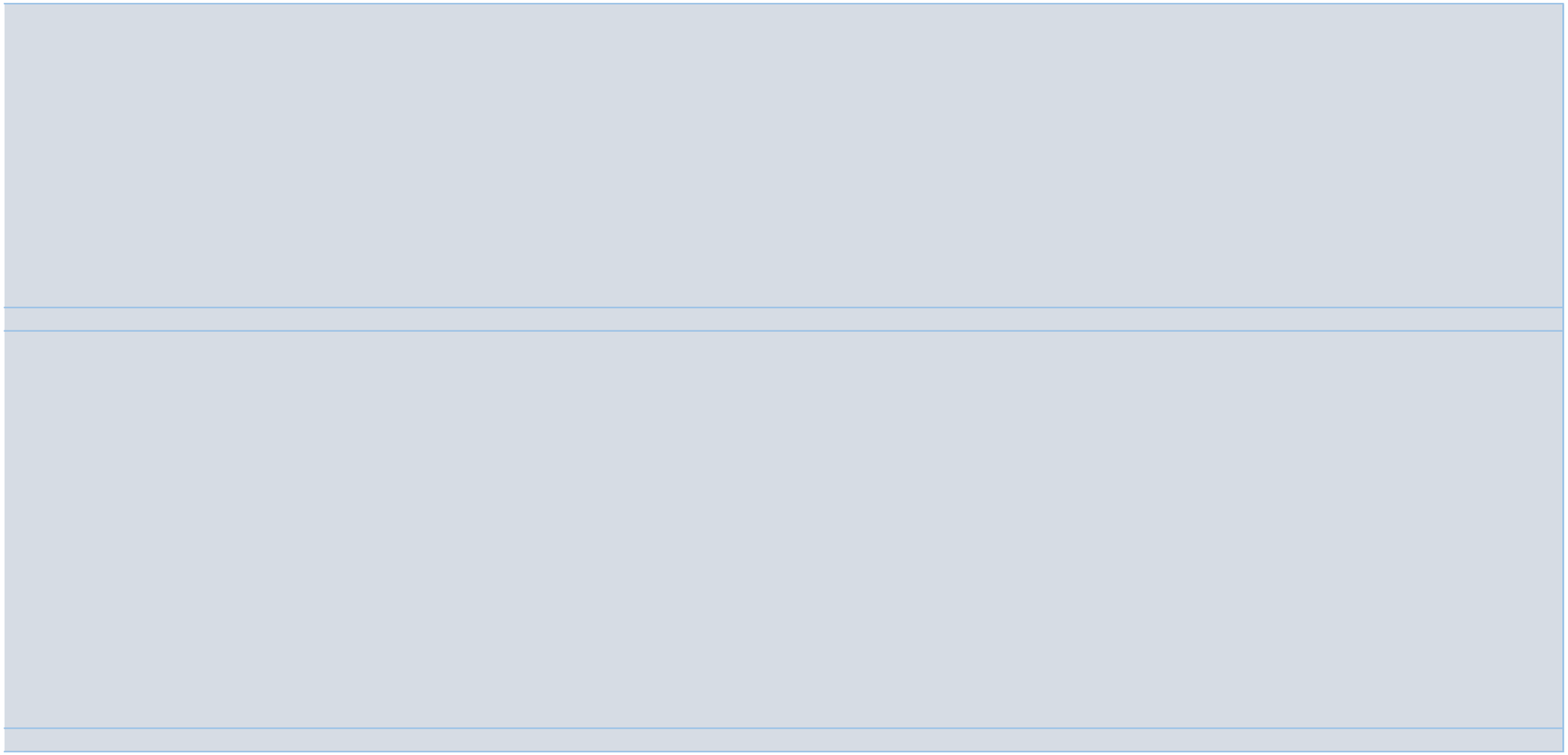


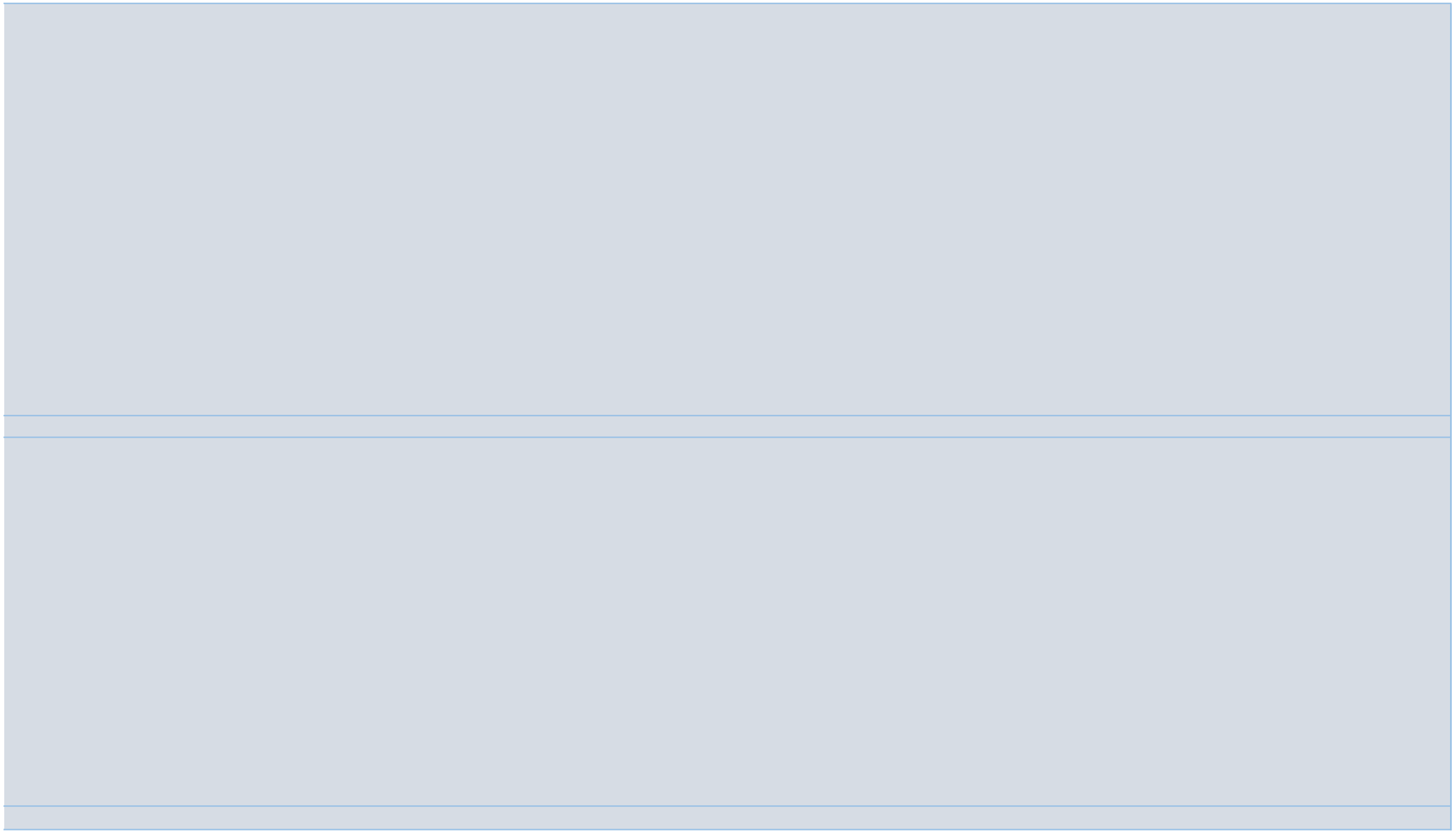


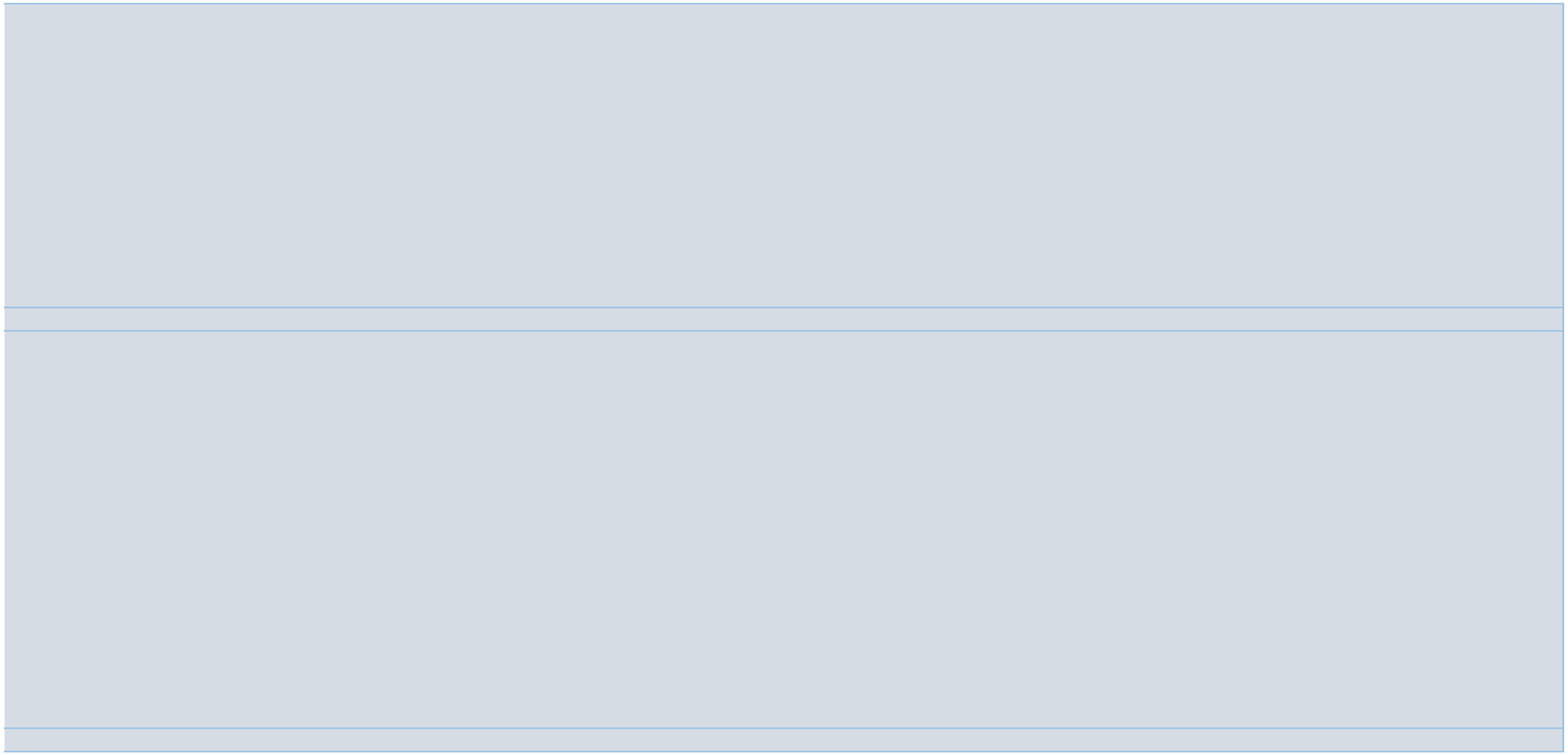


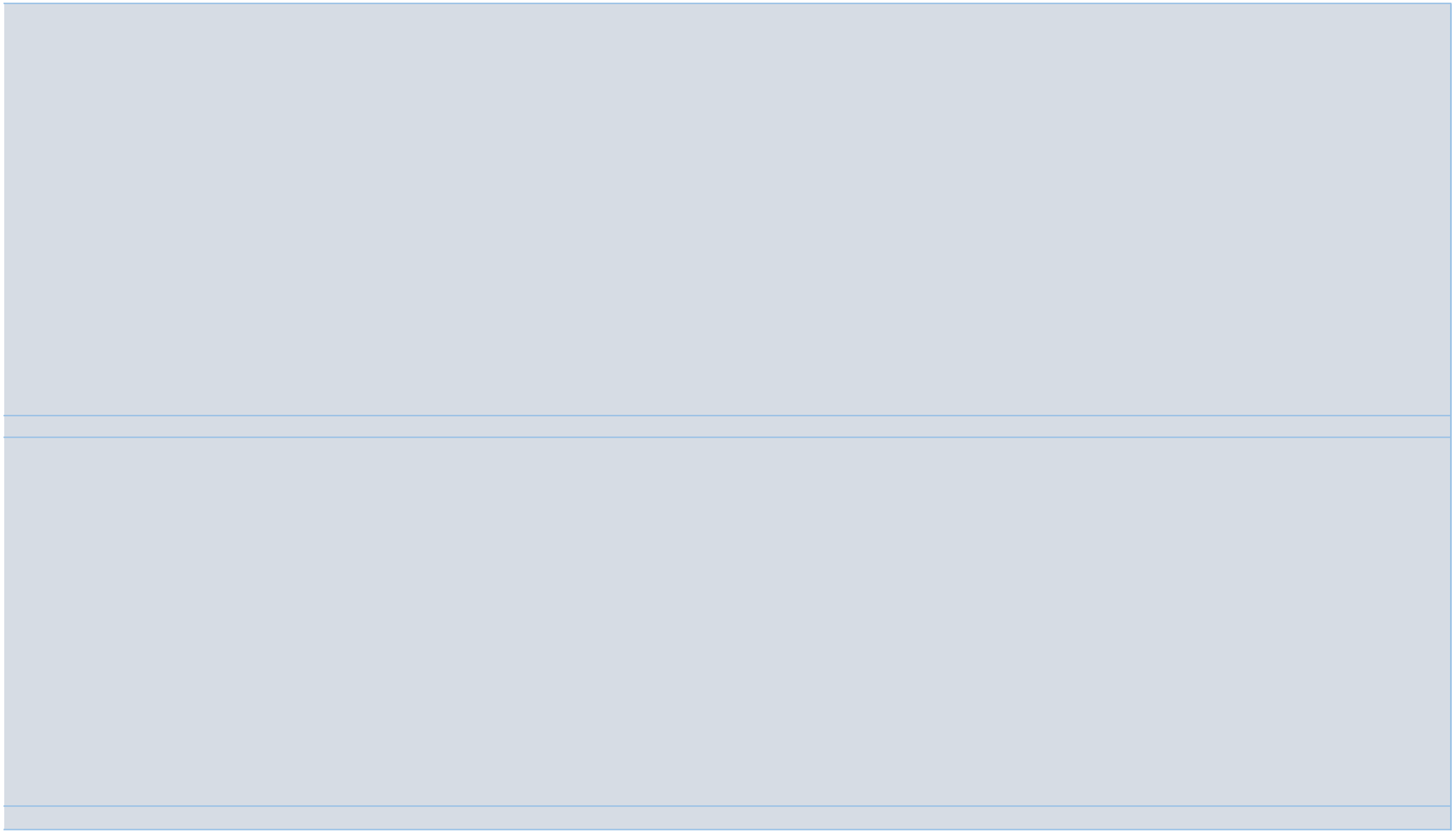


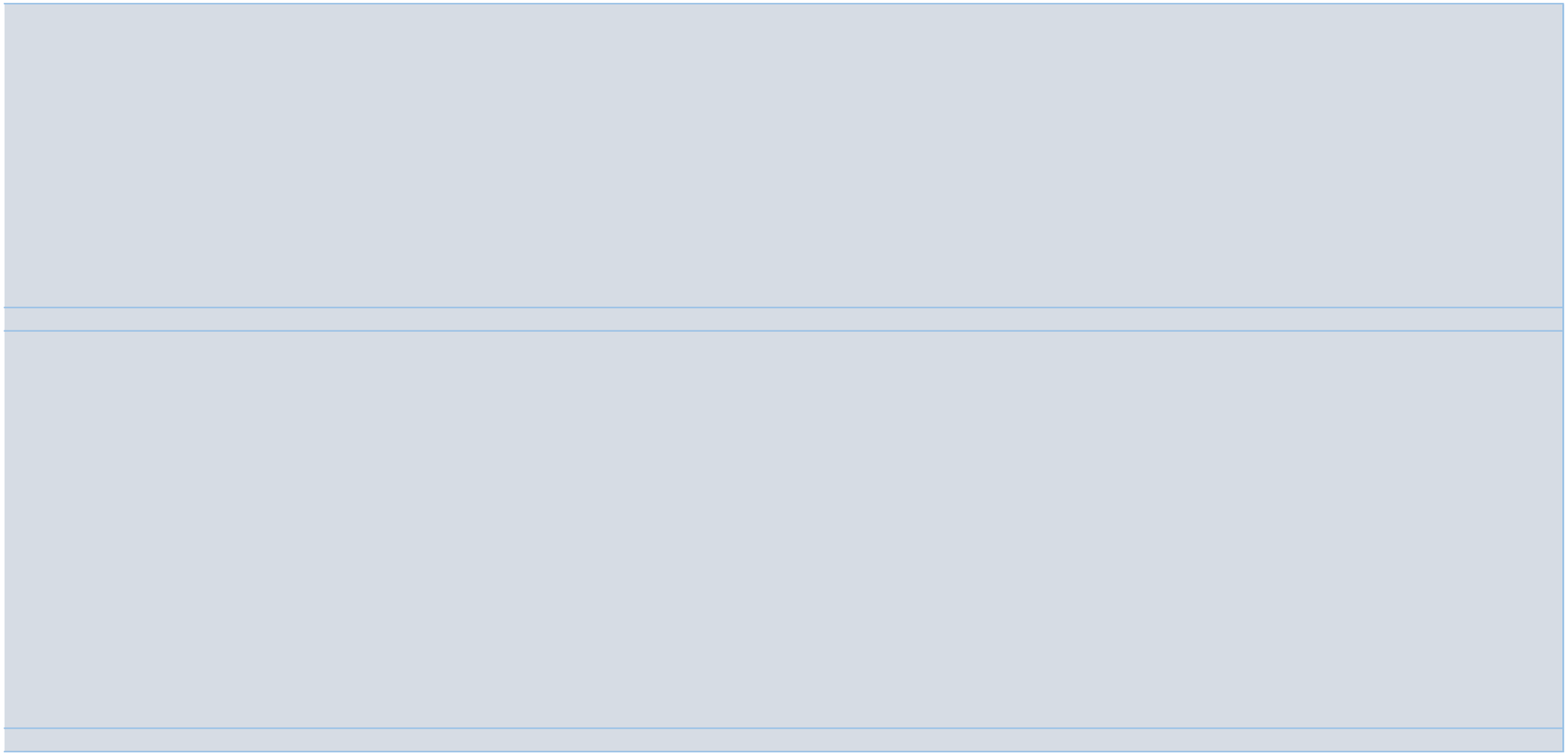


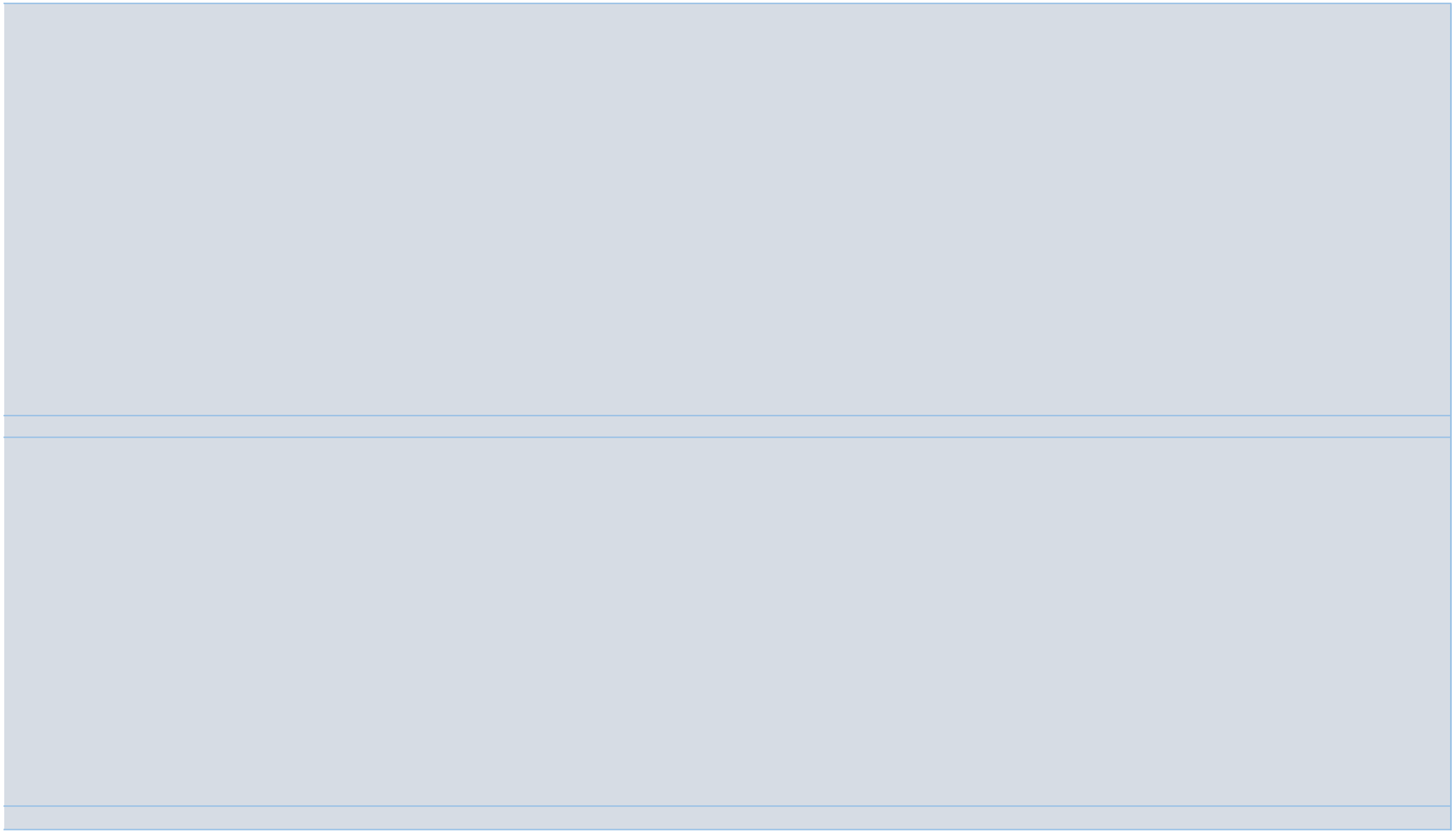


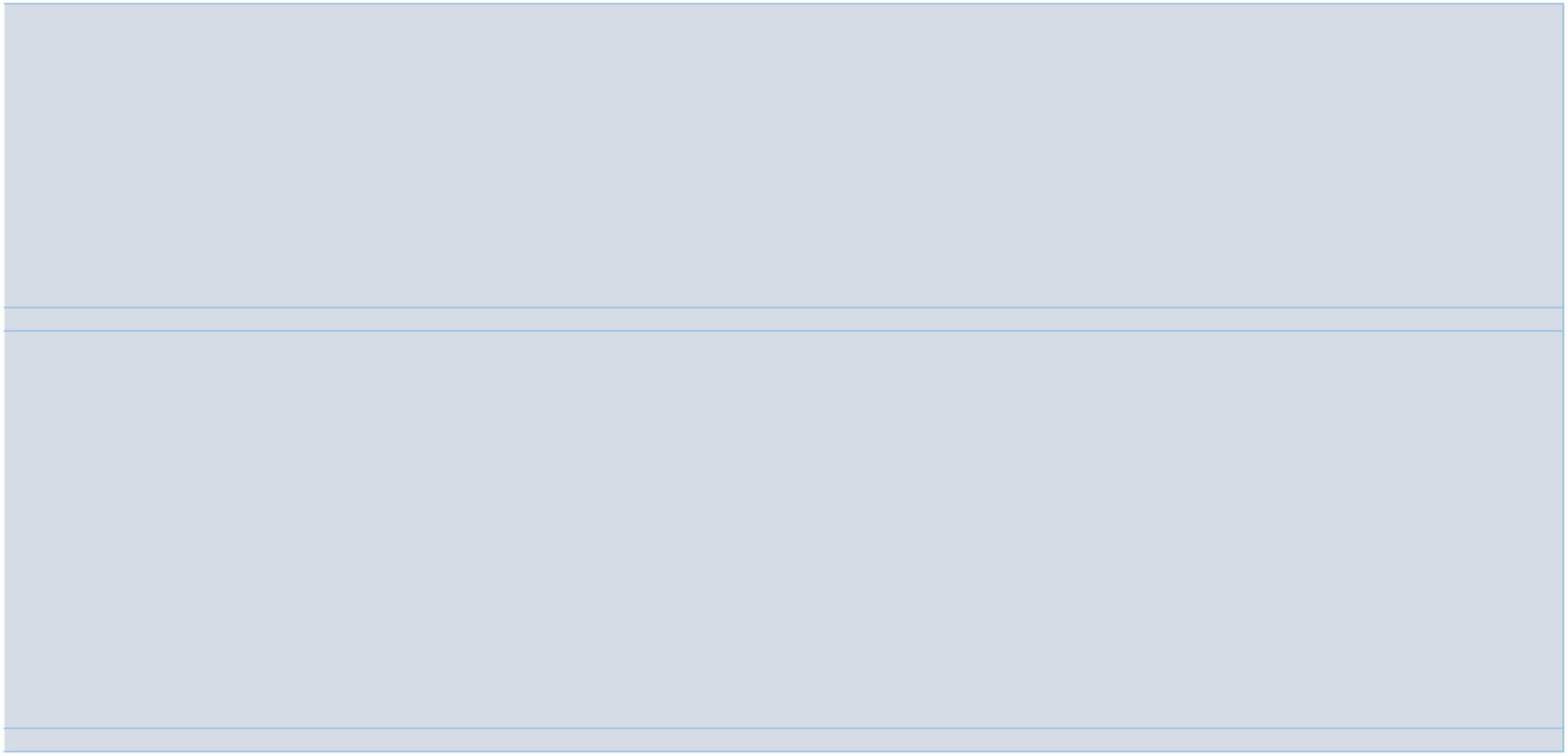


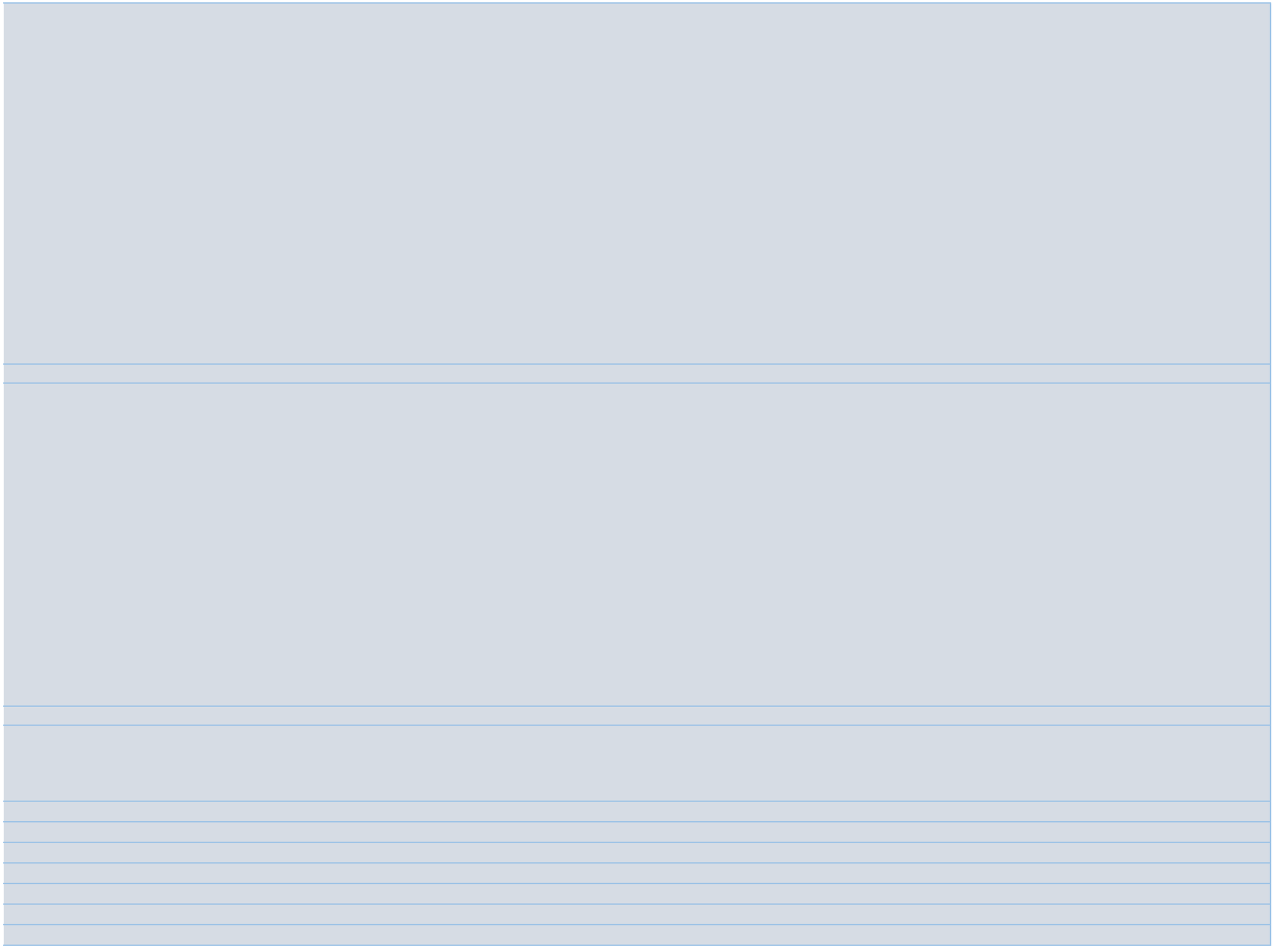


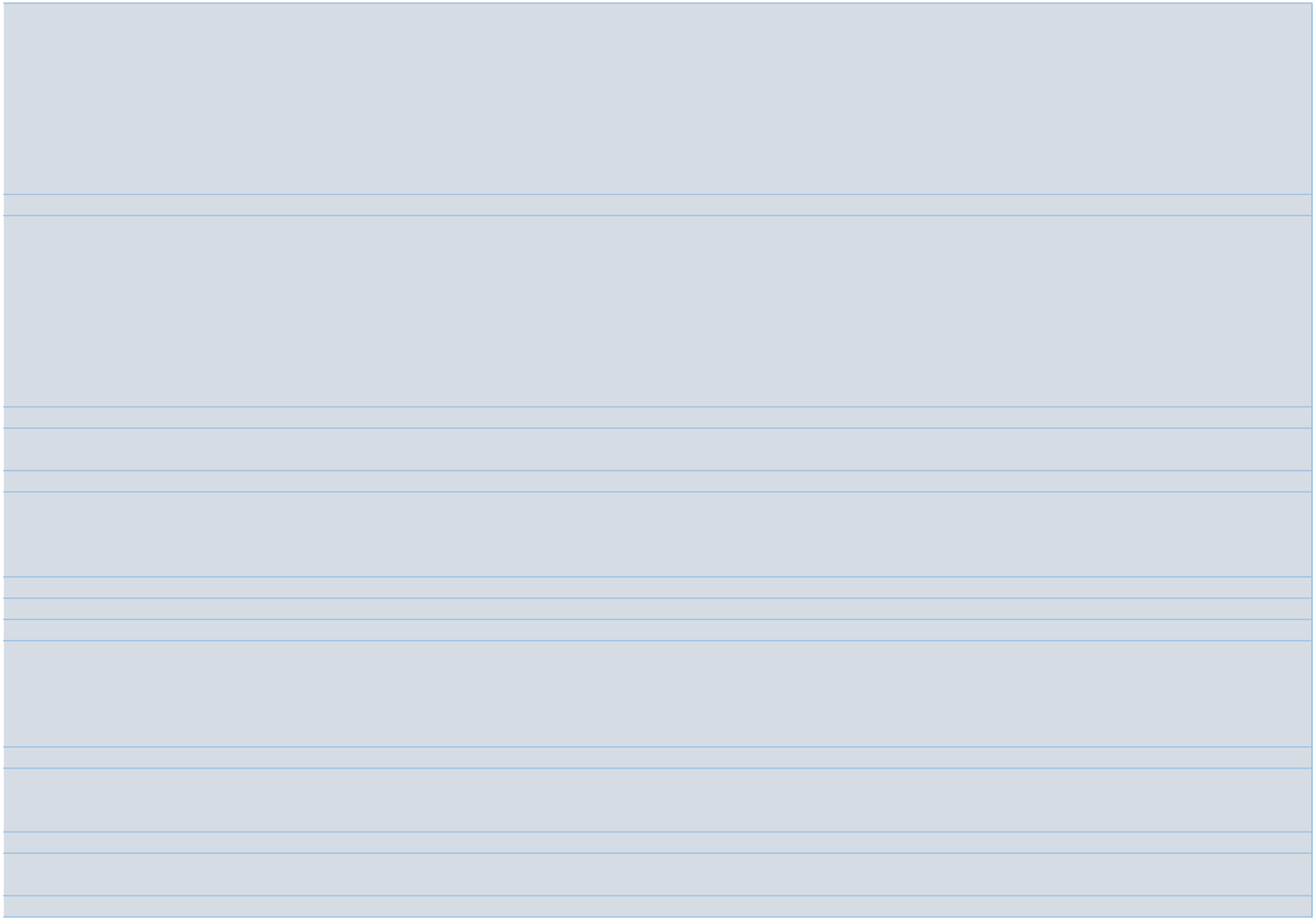


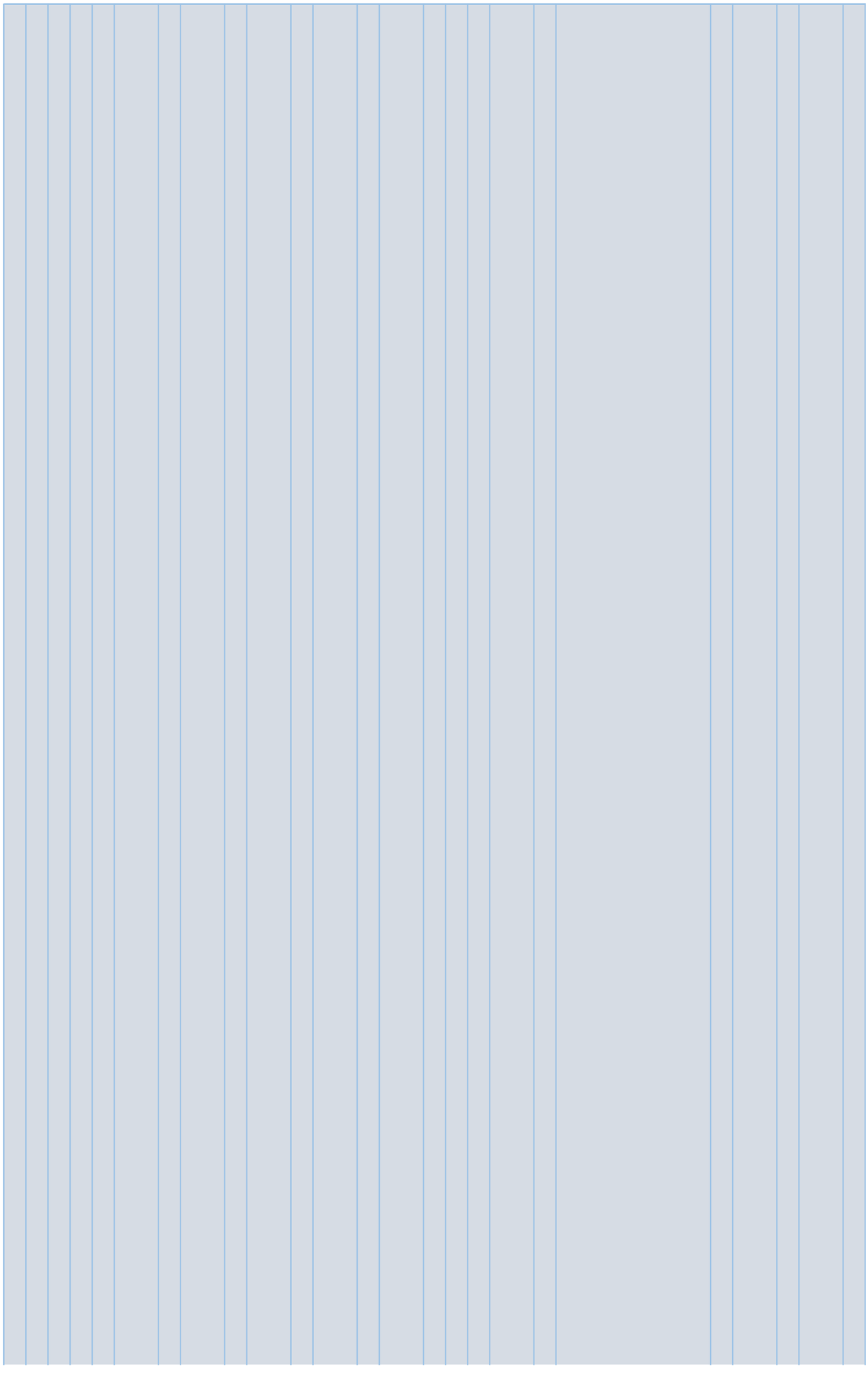


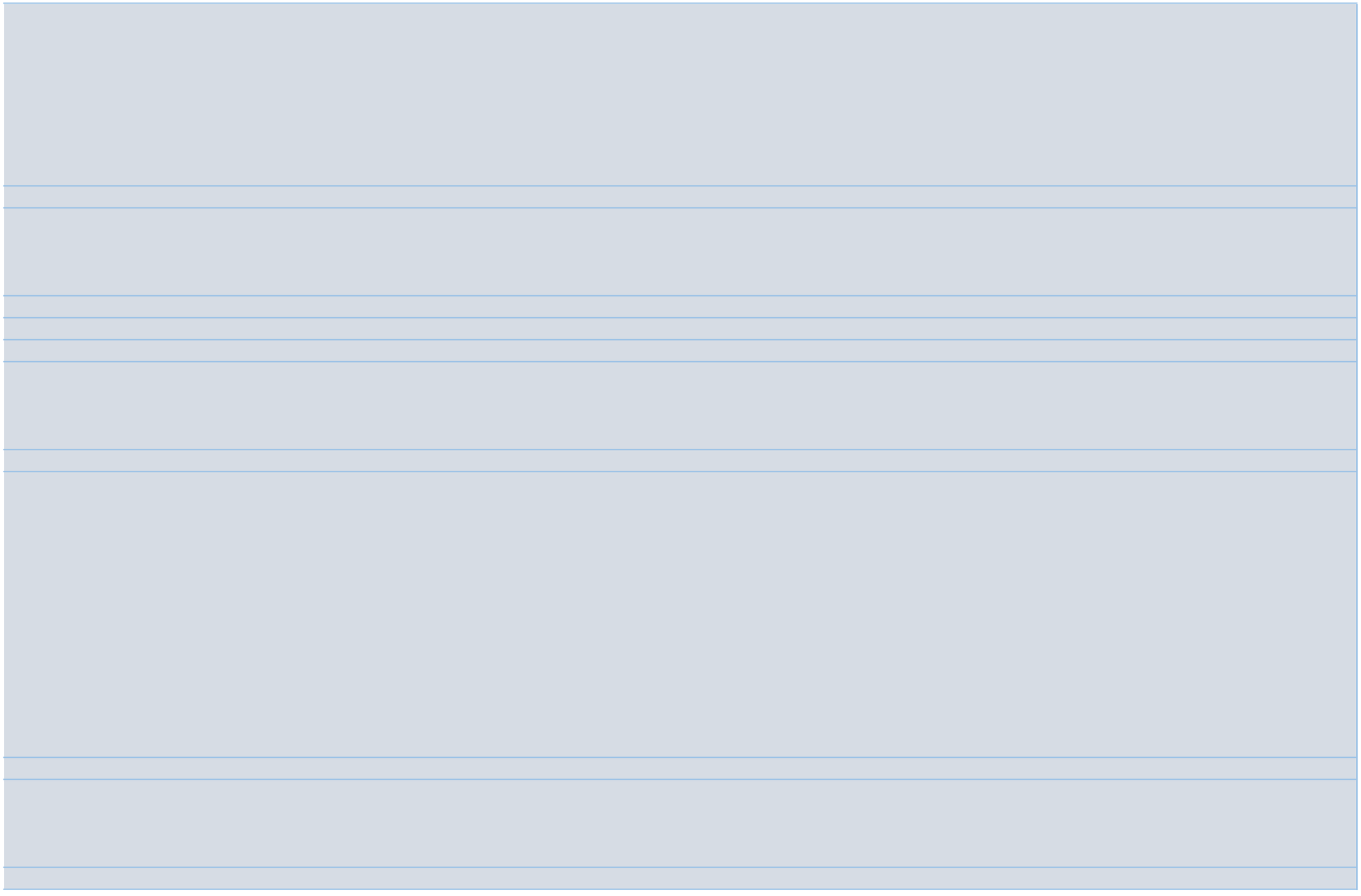








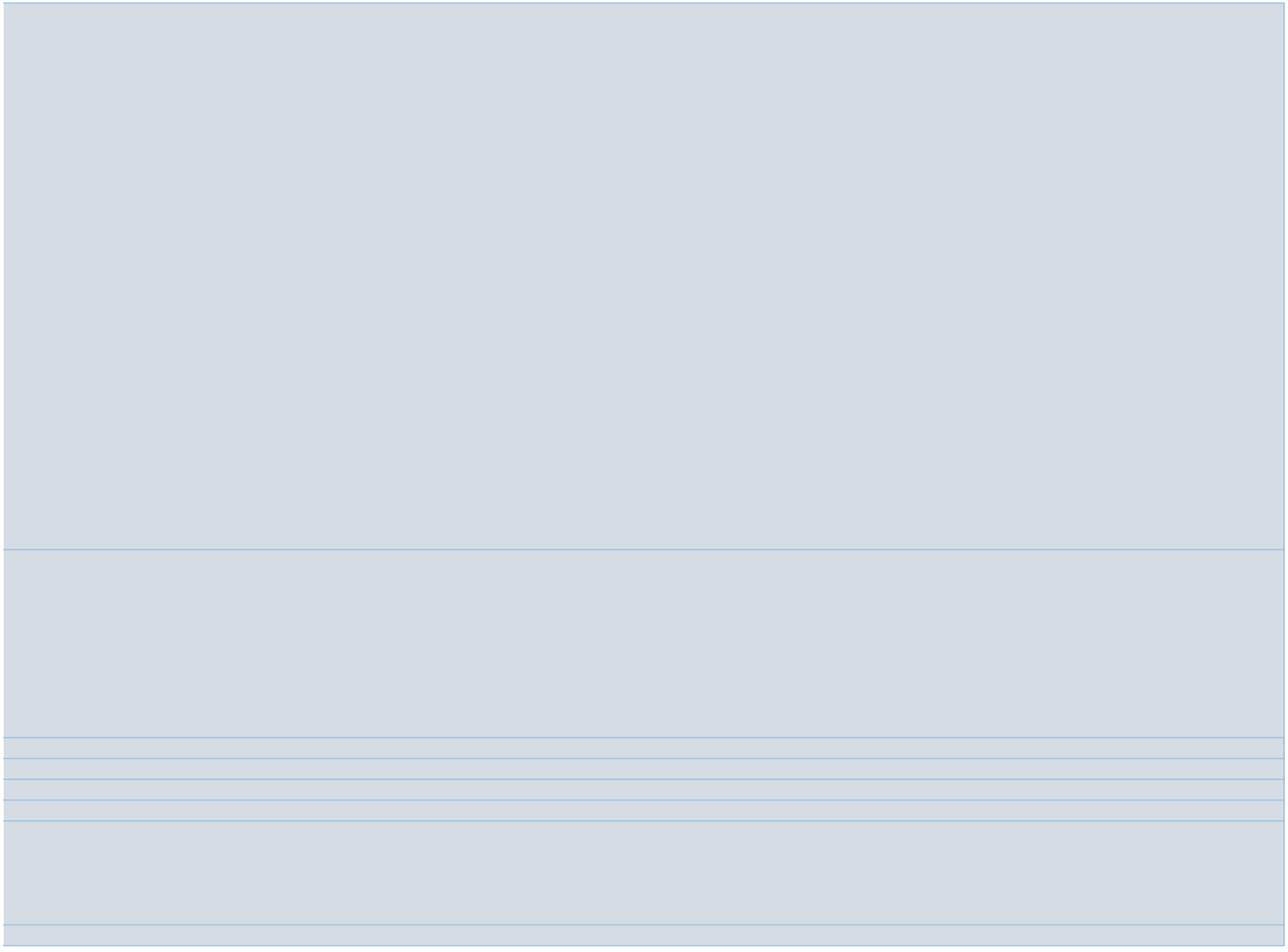


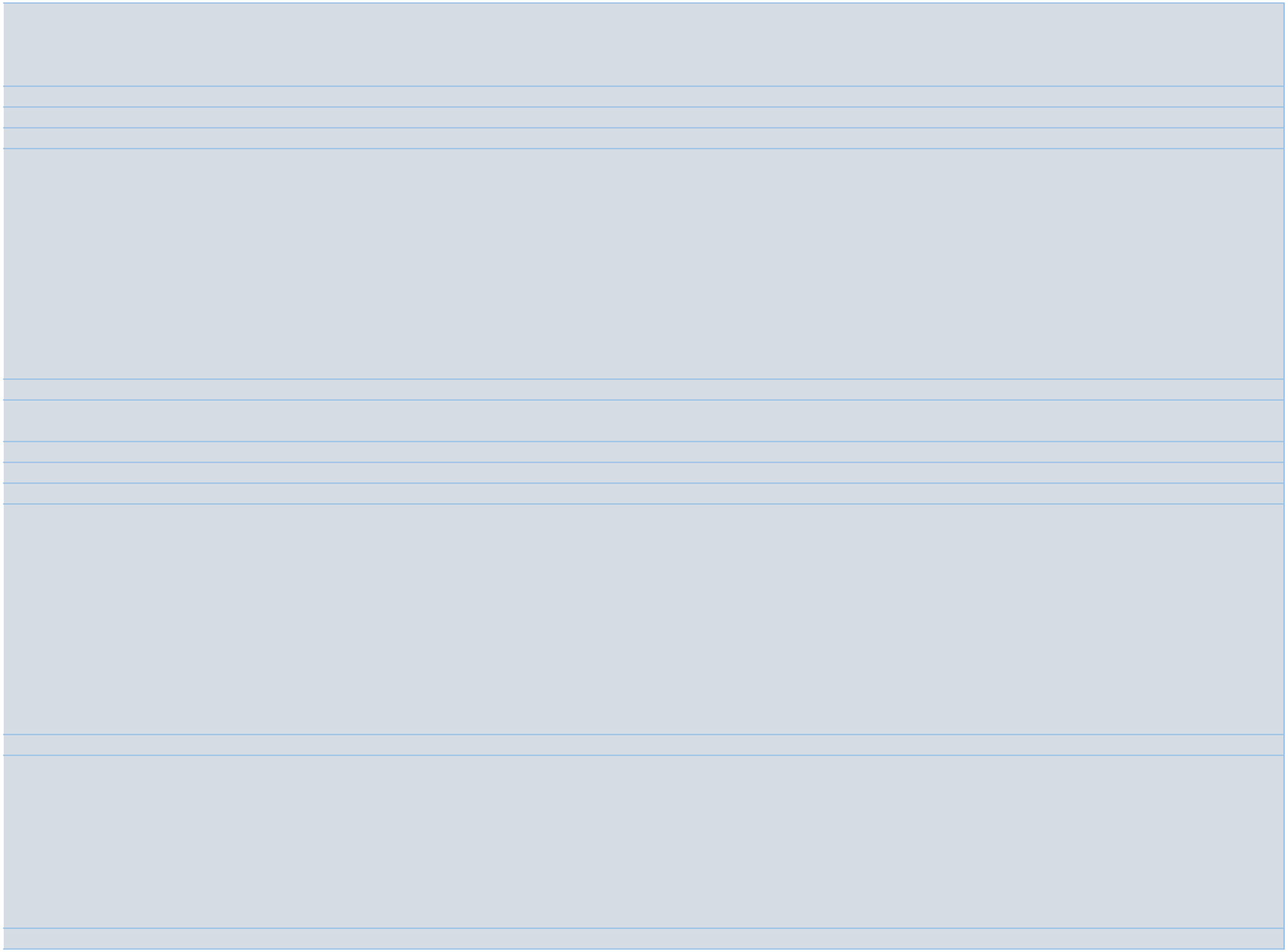


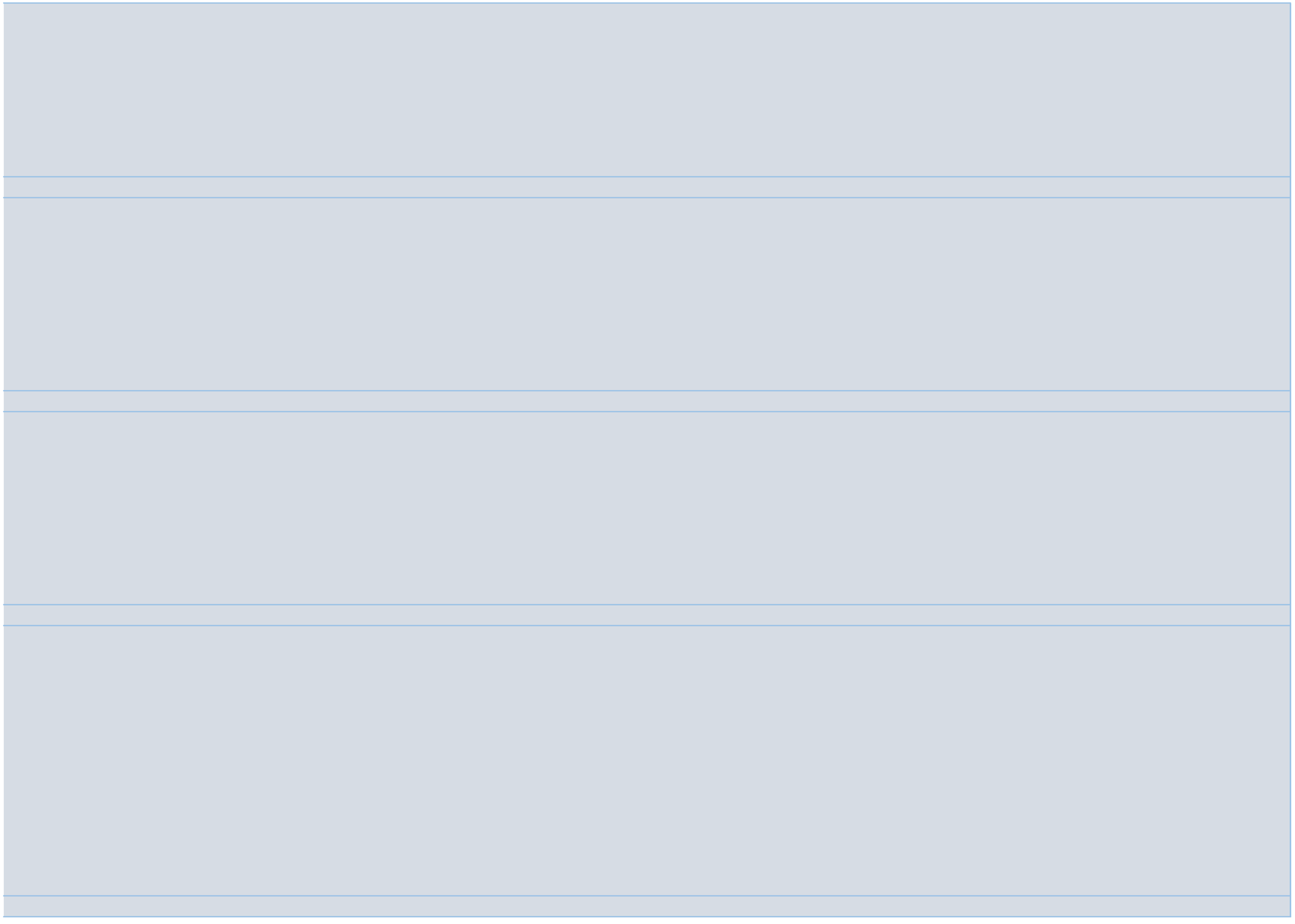
| | Completed on | Duration | Module Assessment Result |
|---|---|---|---|
| | 10-Jan-25 | 18 min | N/A |
| | 10-Jan-25 | 29 min | N/A |

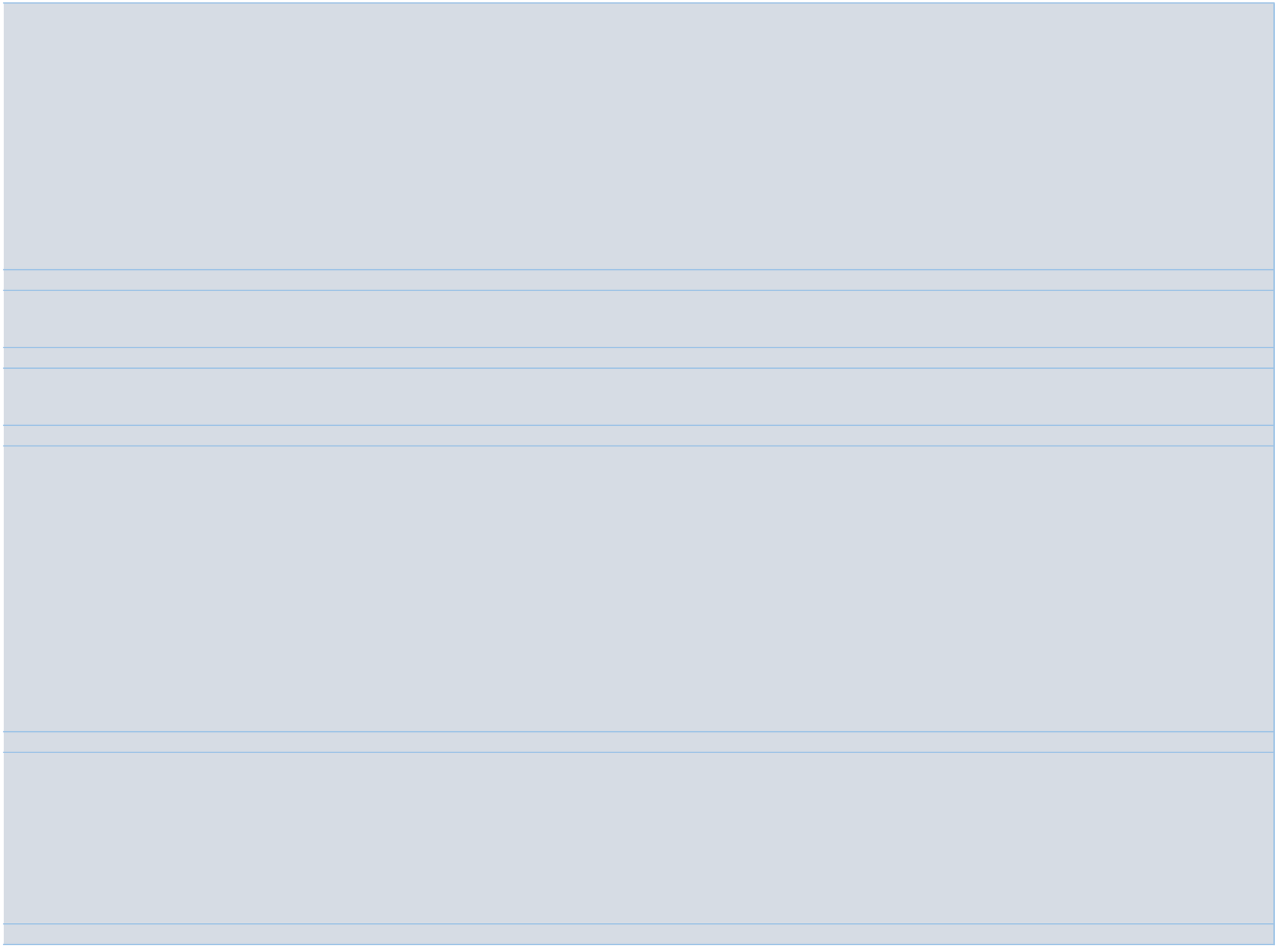
| | | | |
|---|---|---|---|
| | 10-Jan-25 | 10 min | N/A |

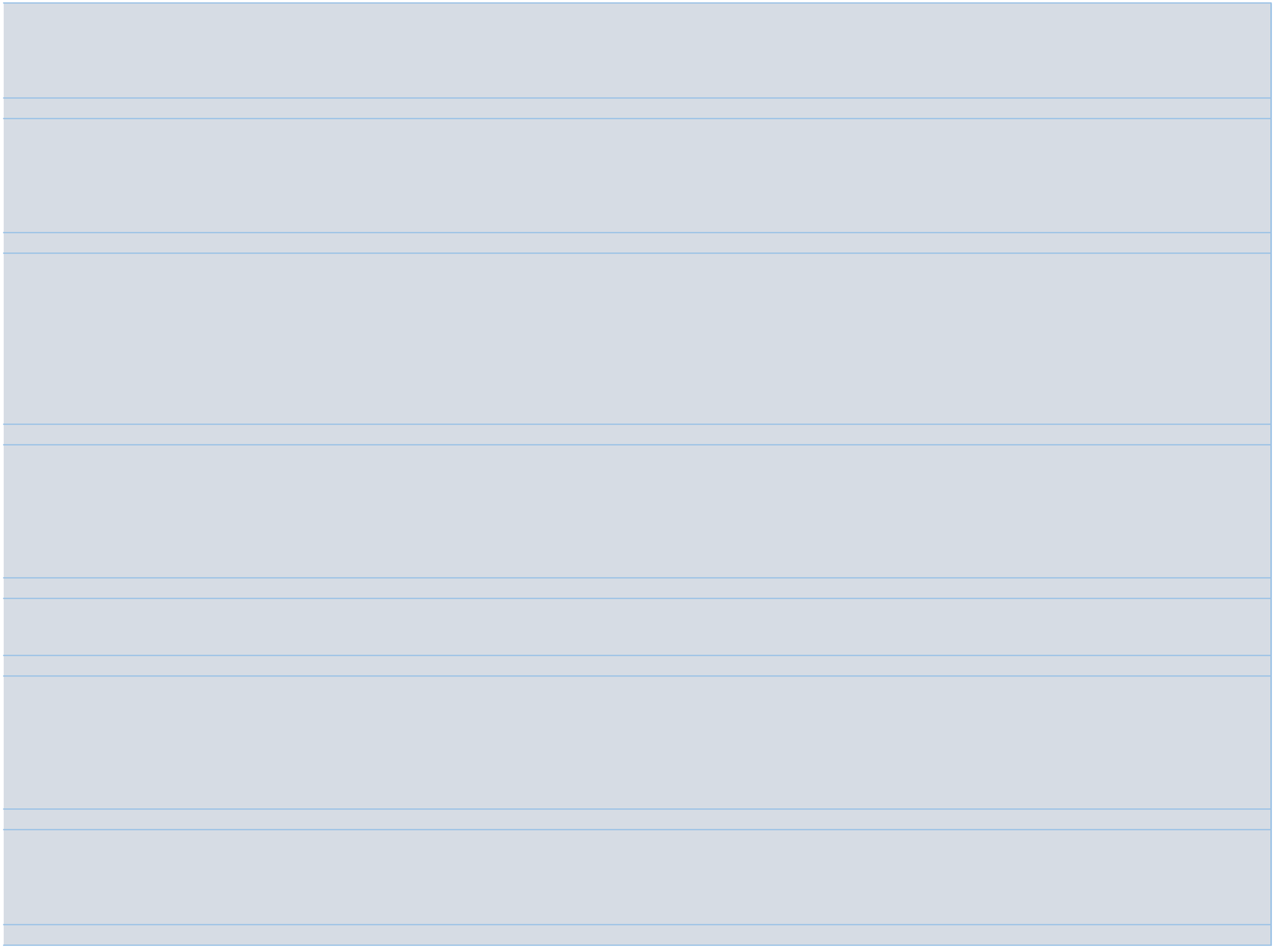
Sun, Oct
20, 8:07 AM

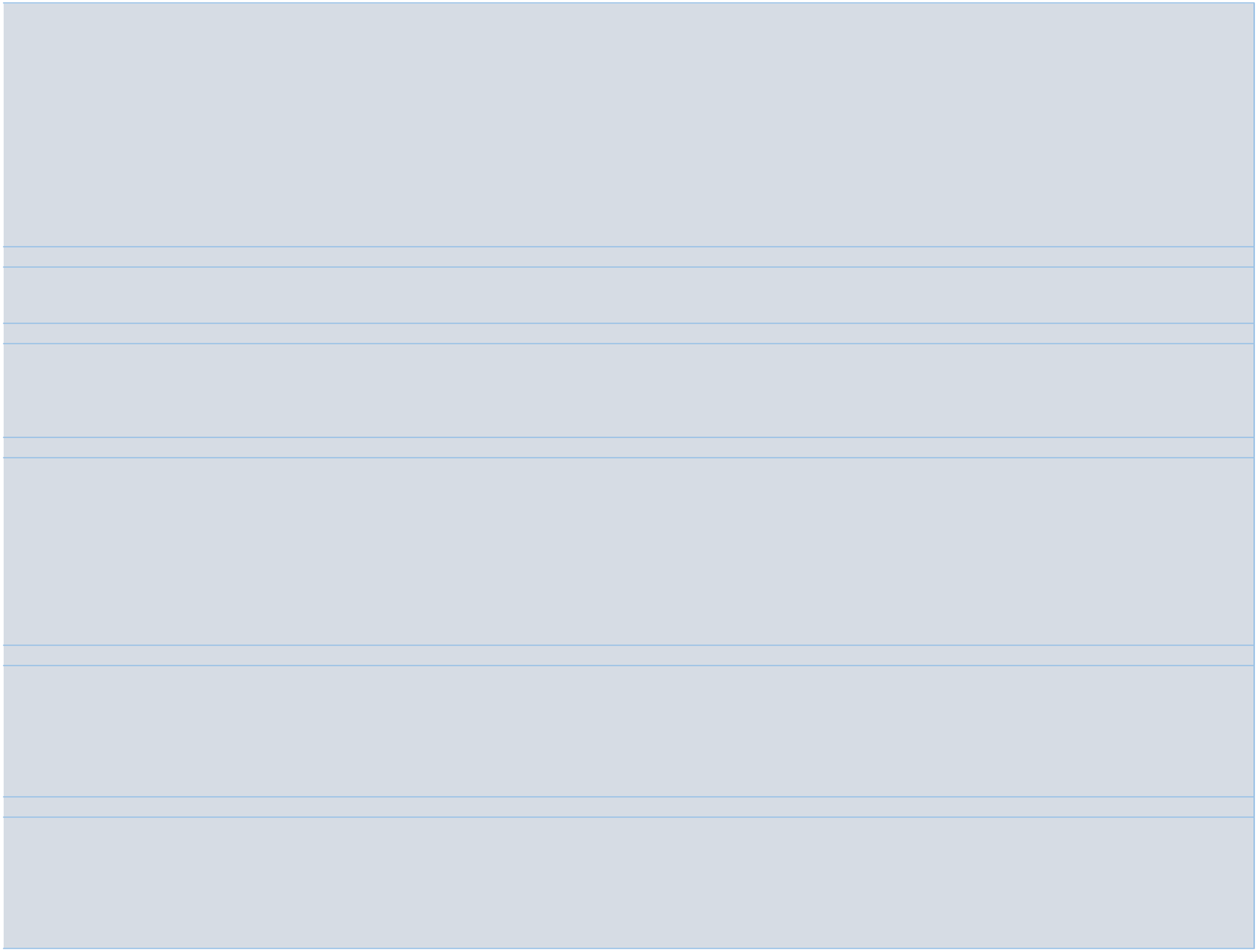


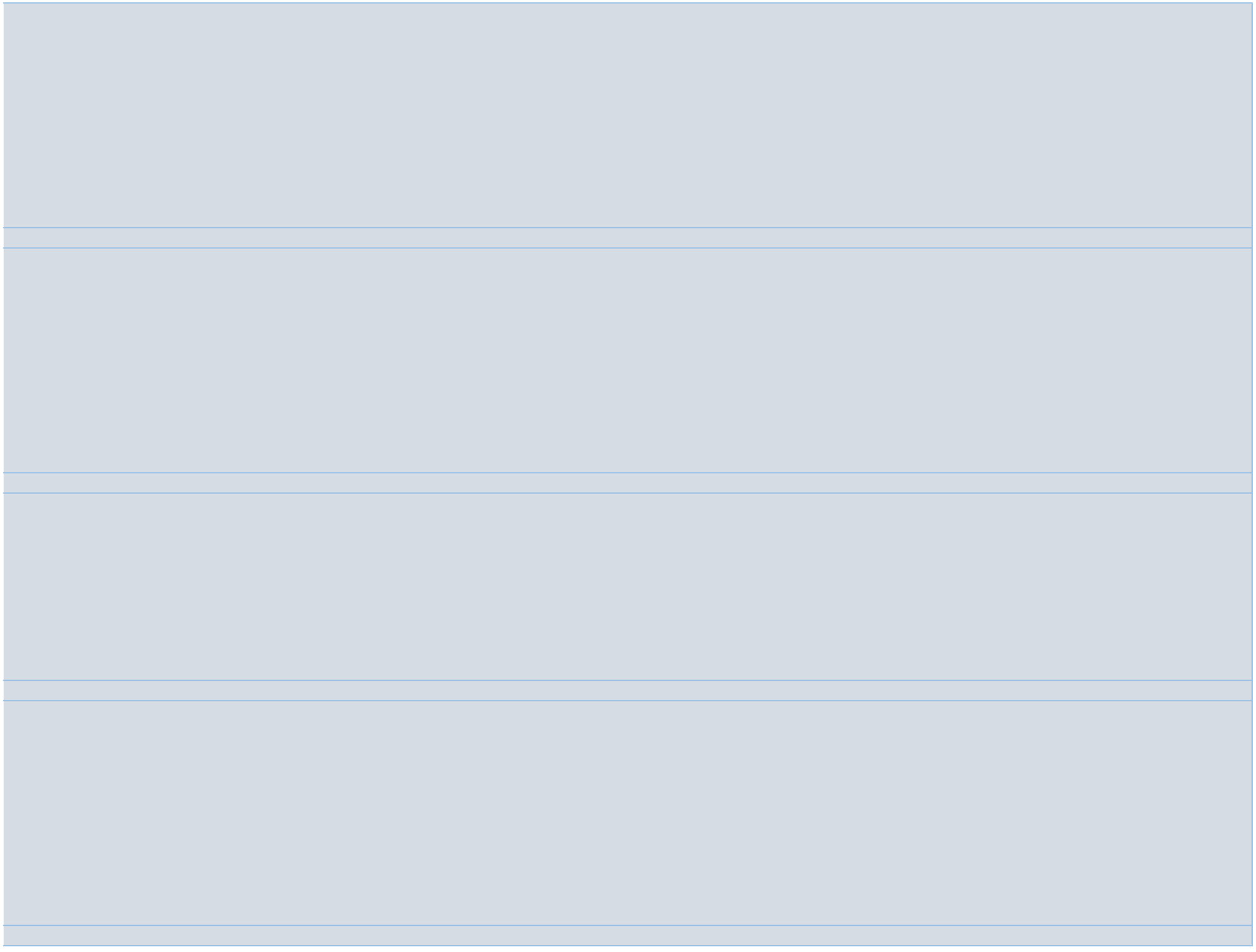












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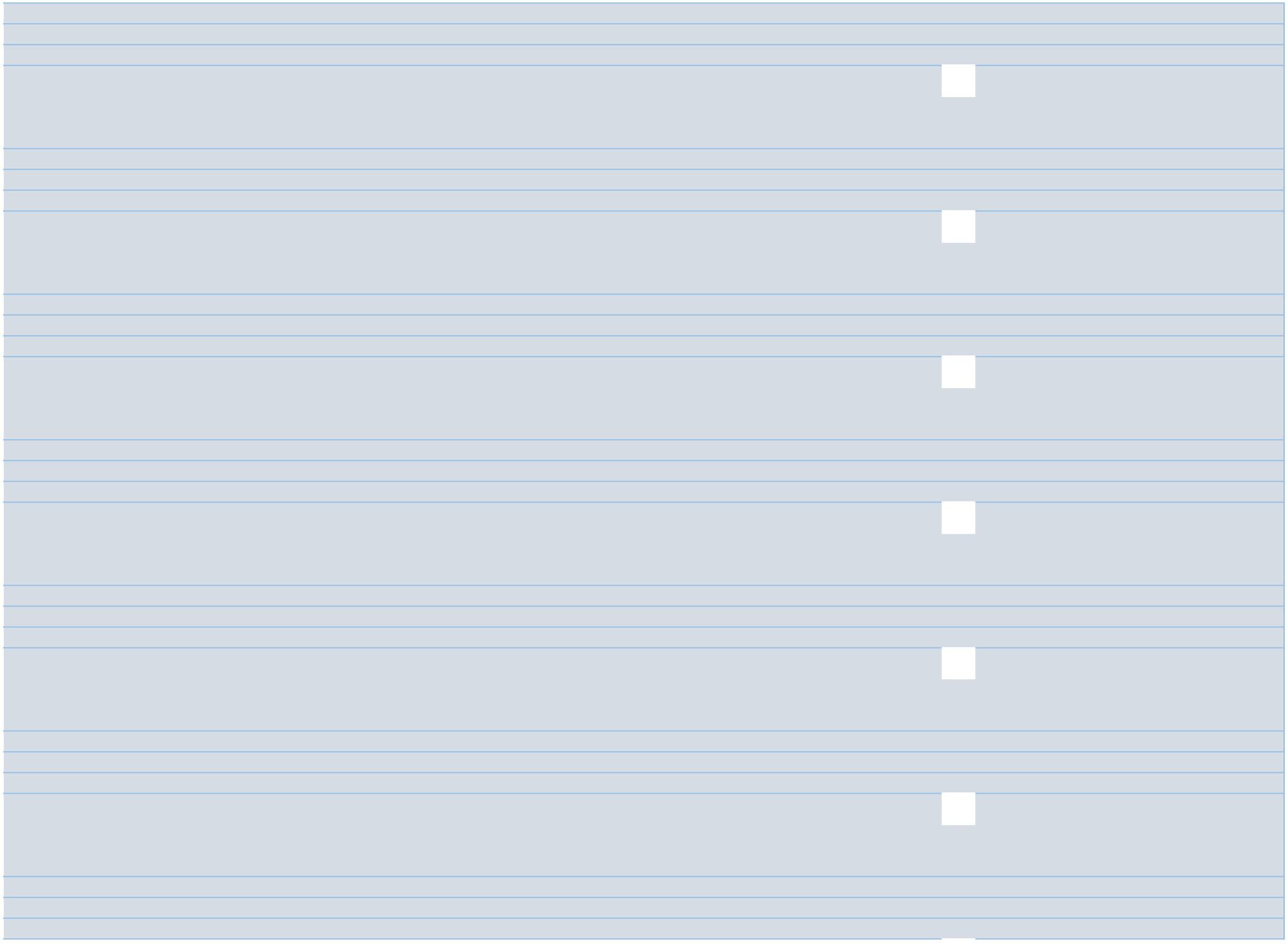
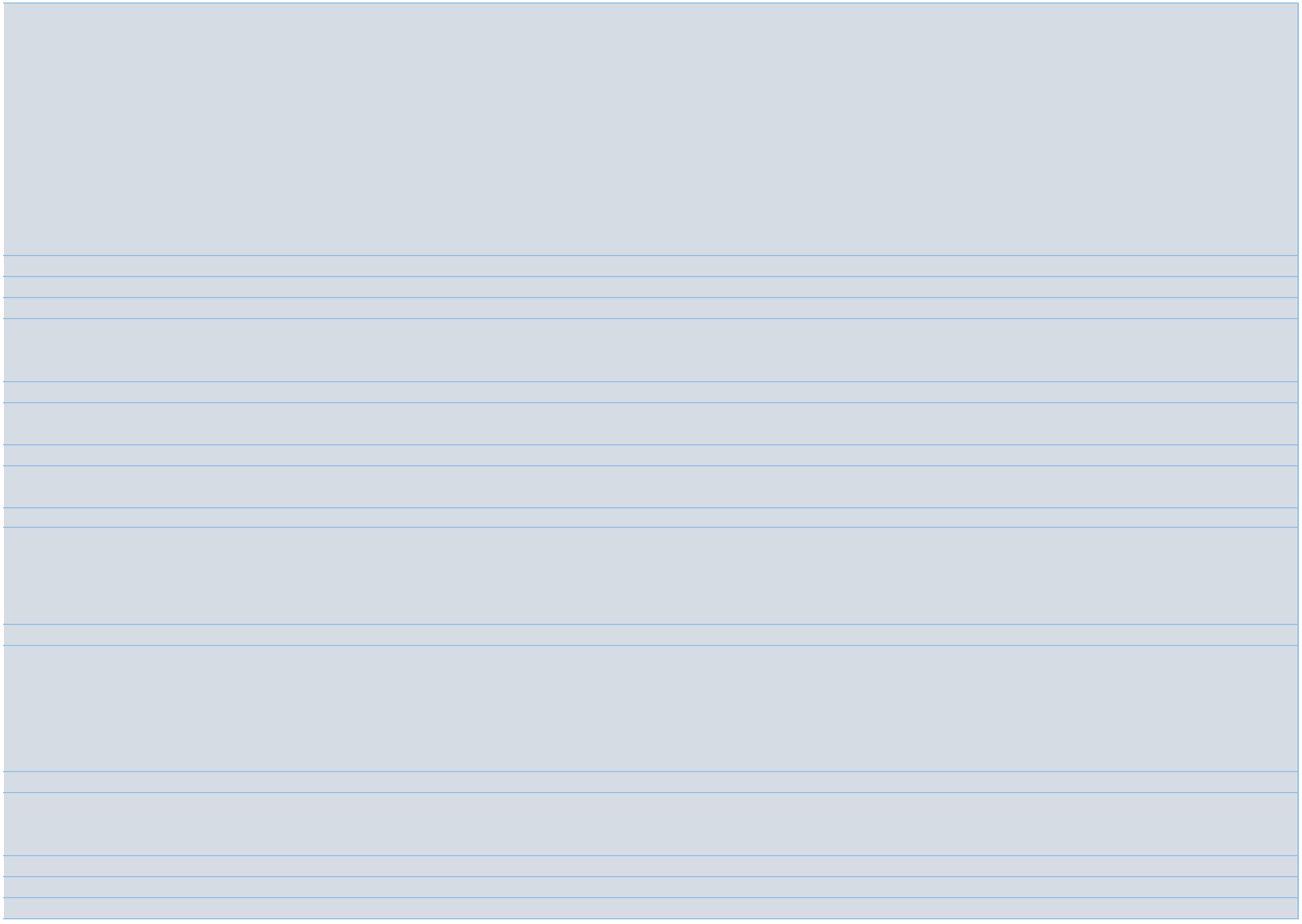
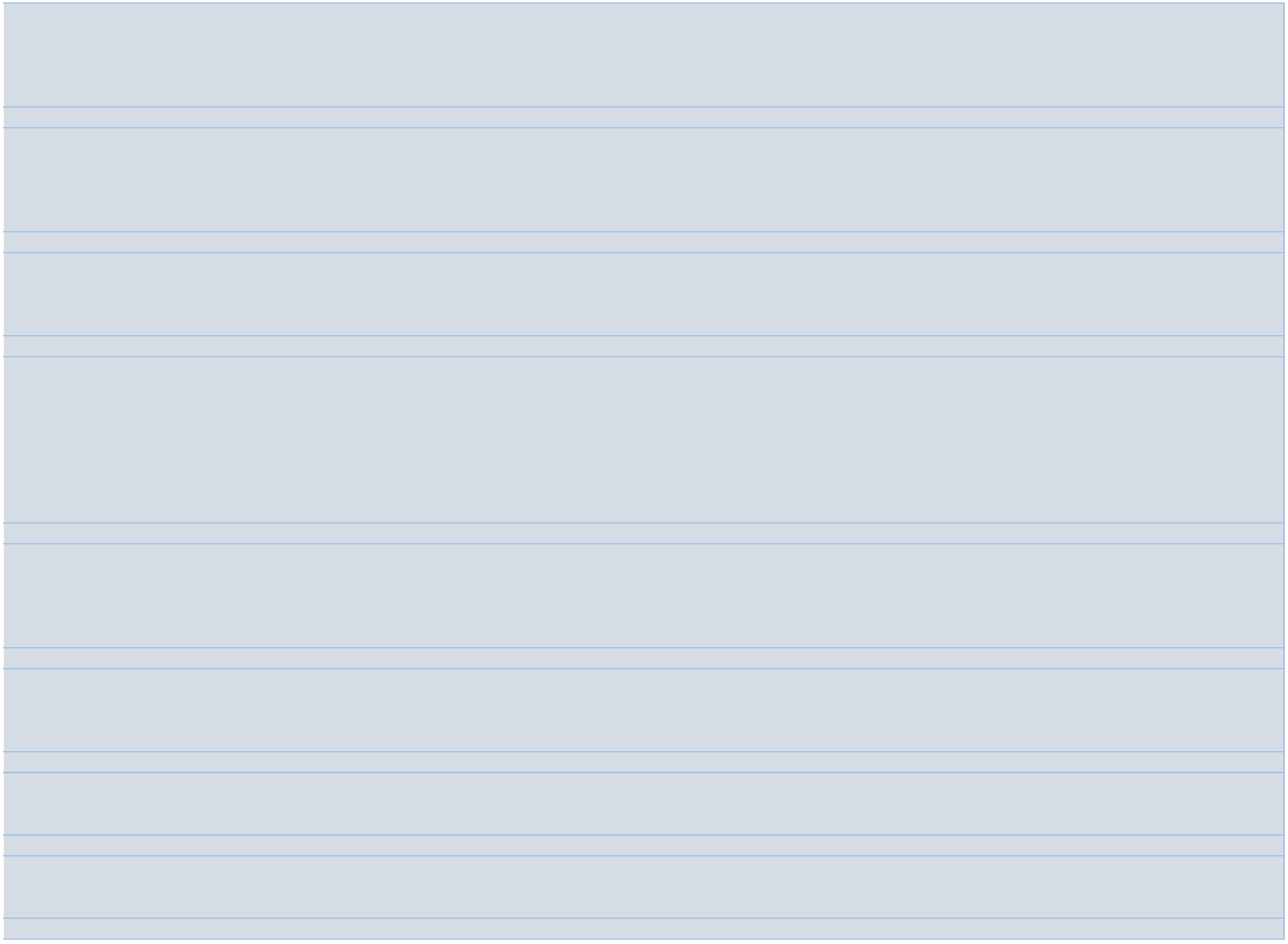
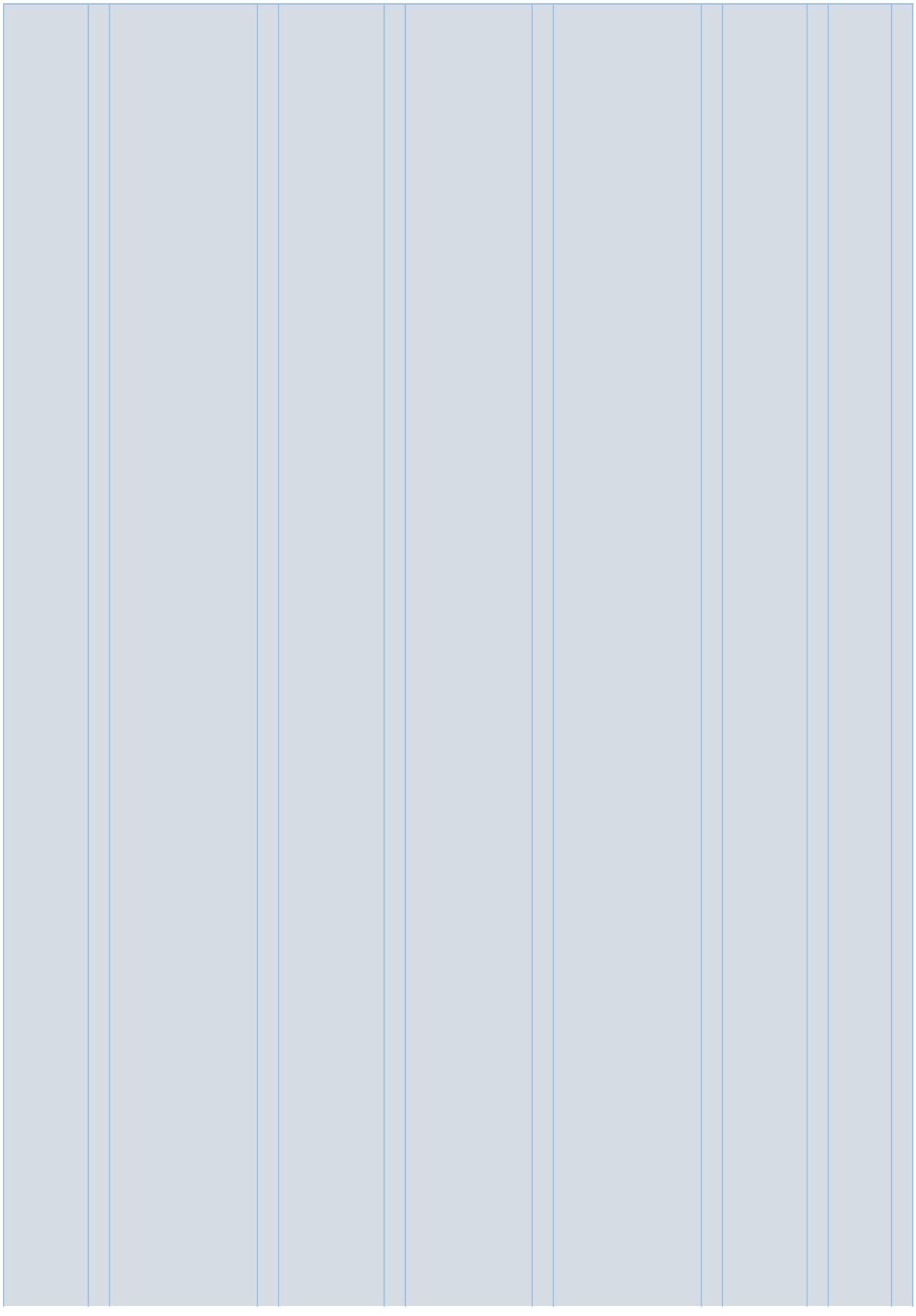
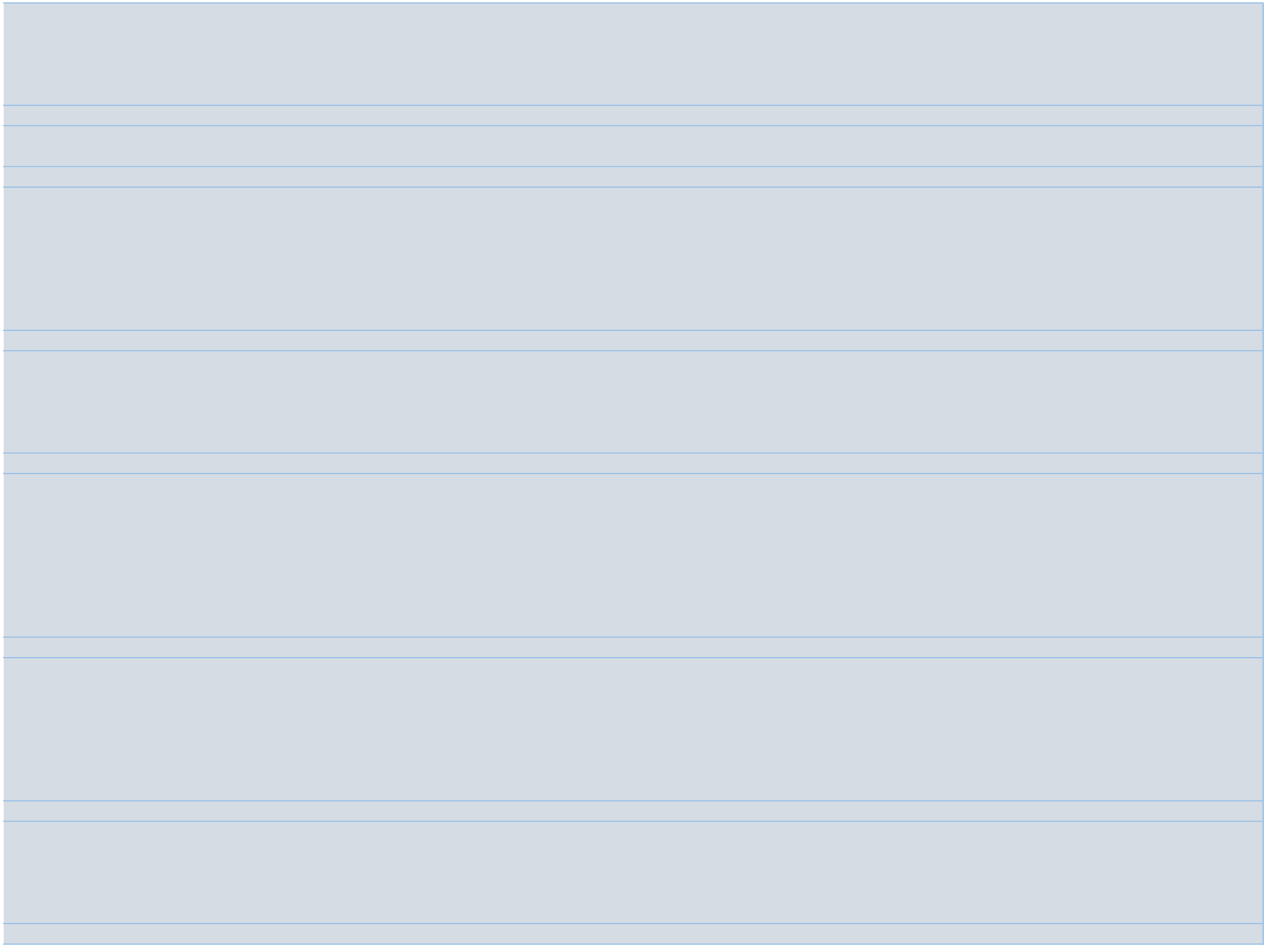
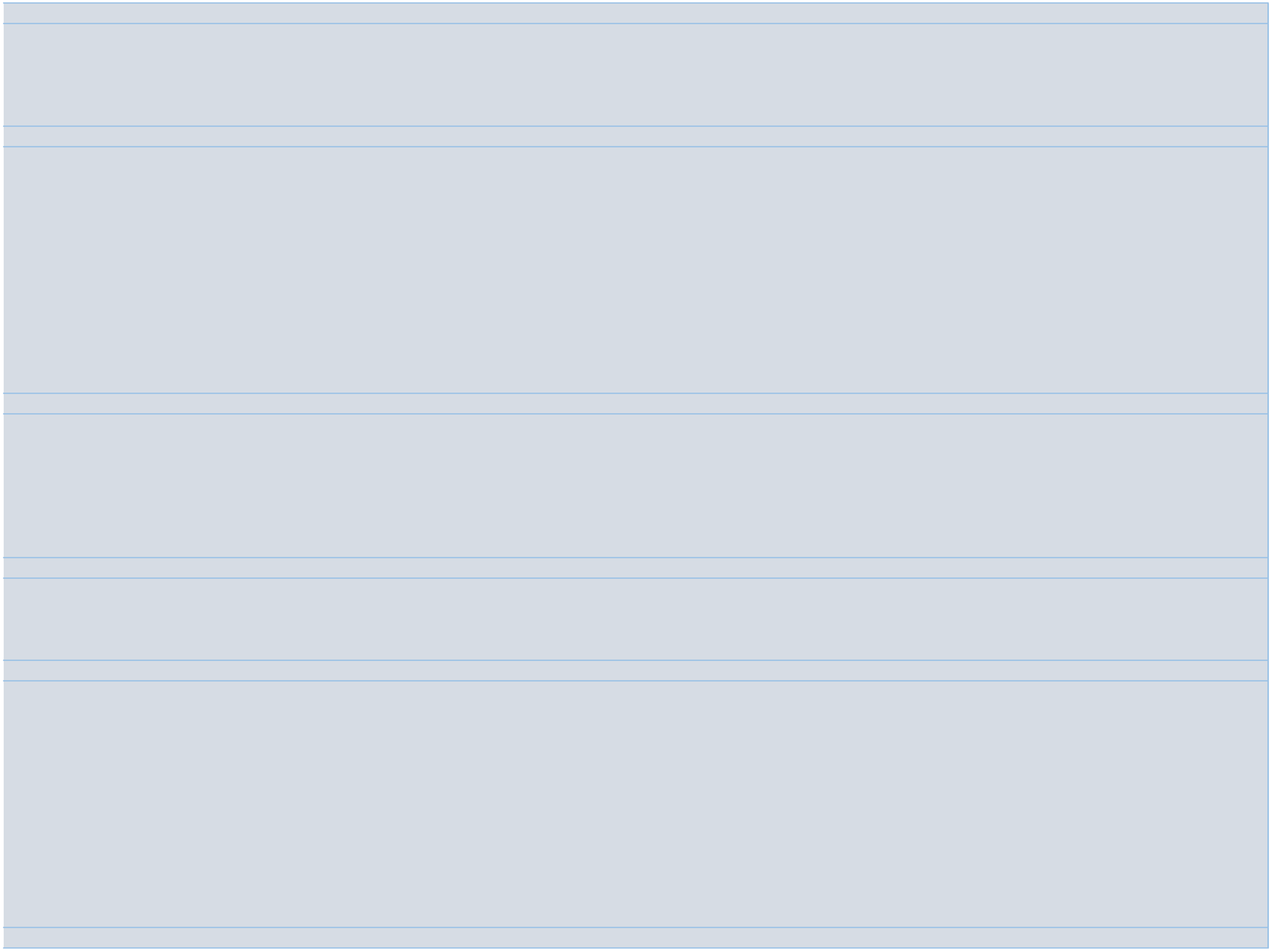


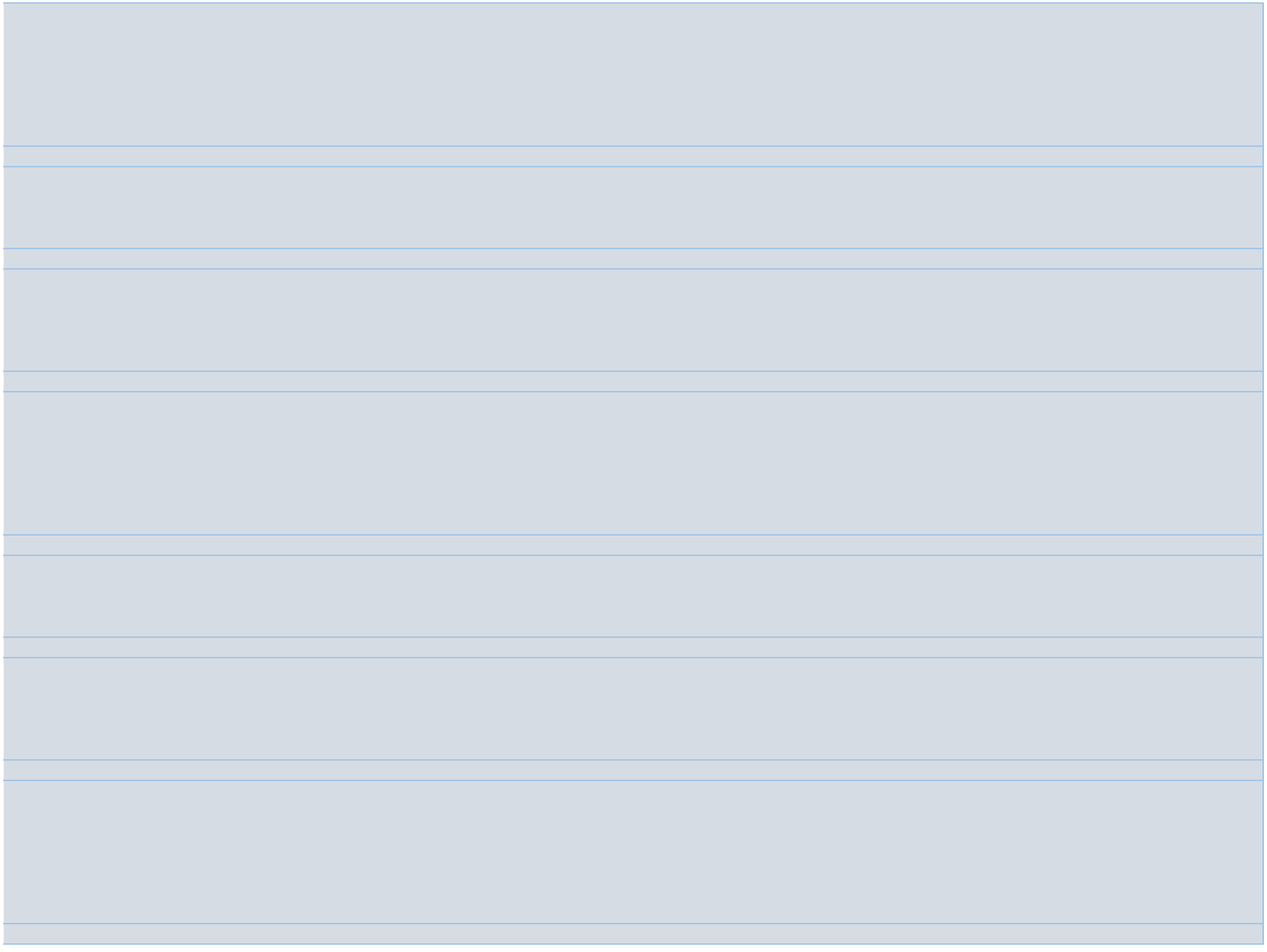


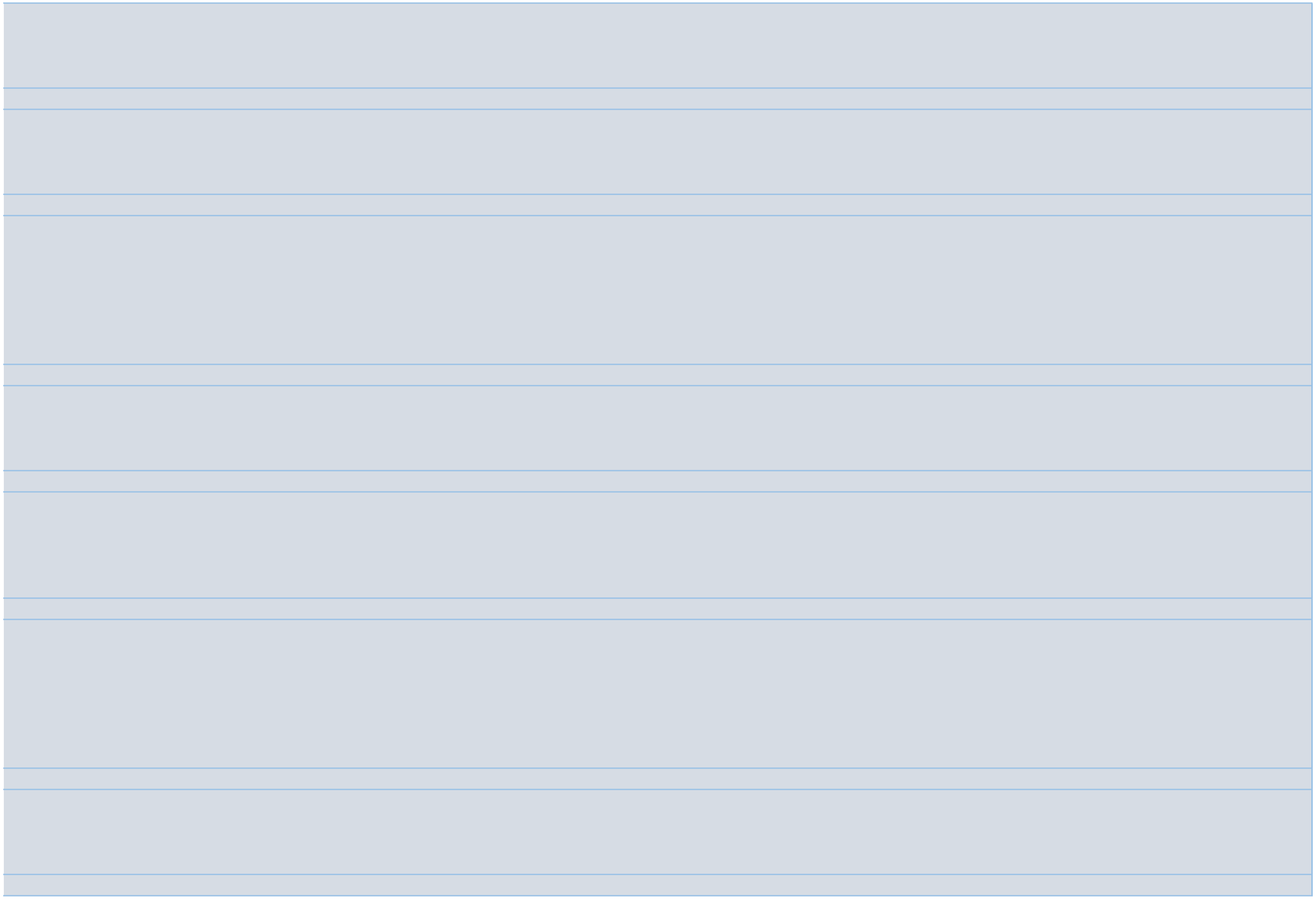


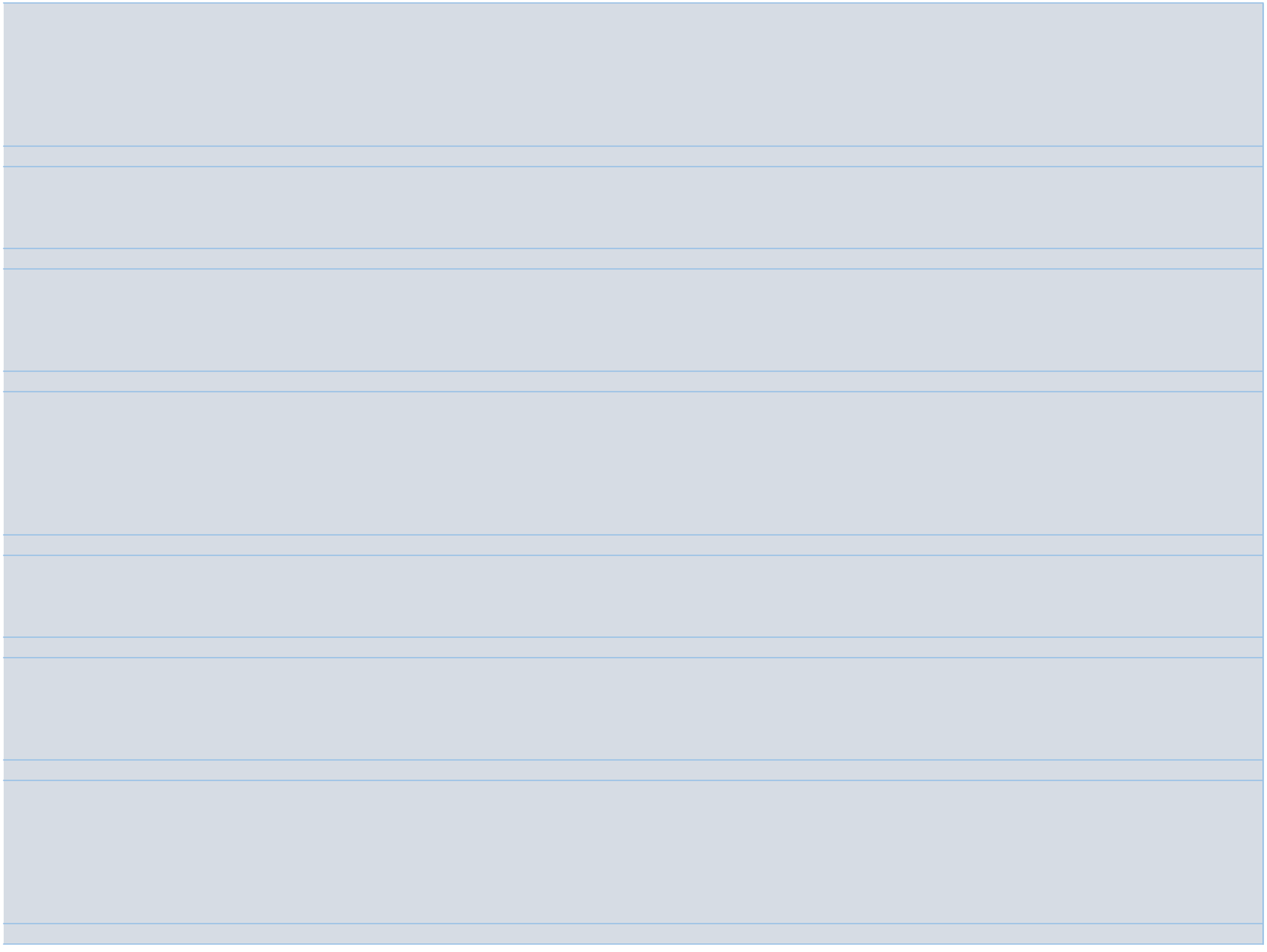


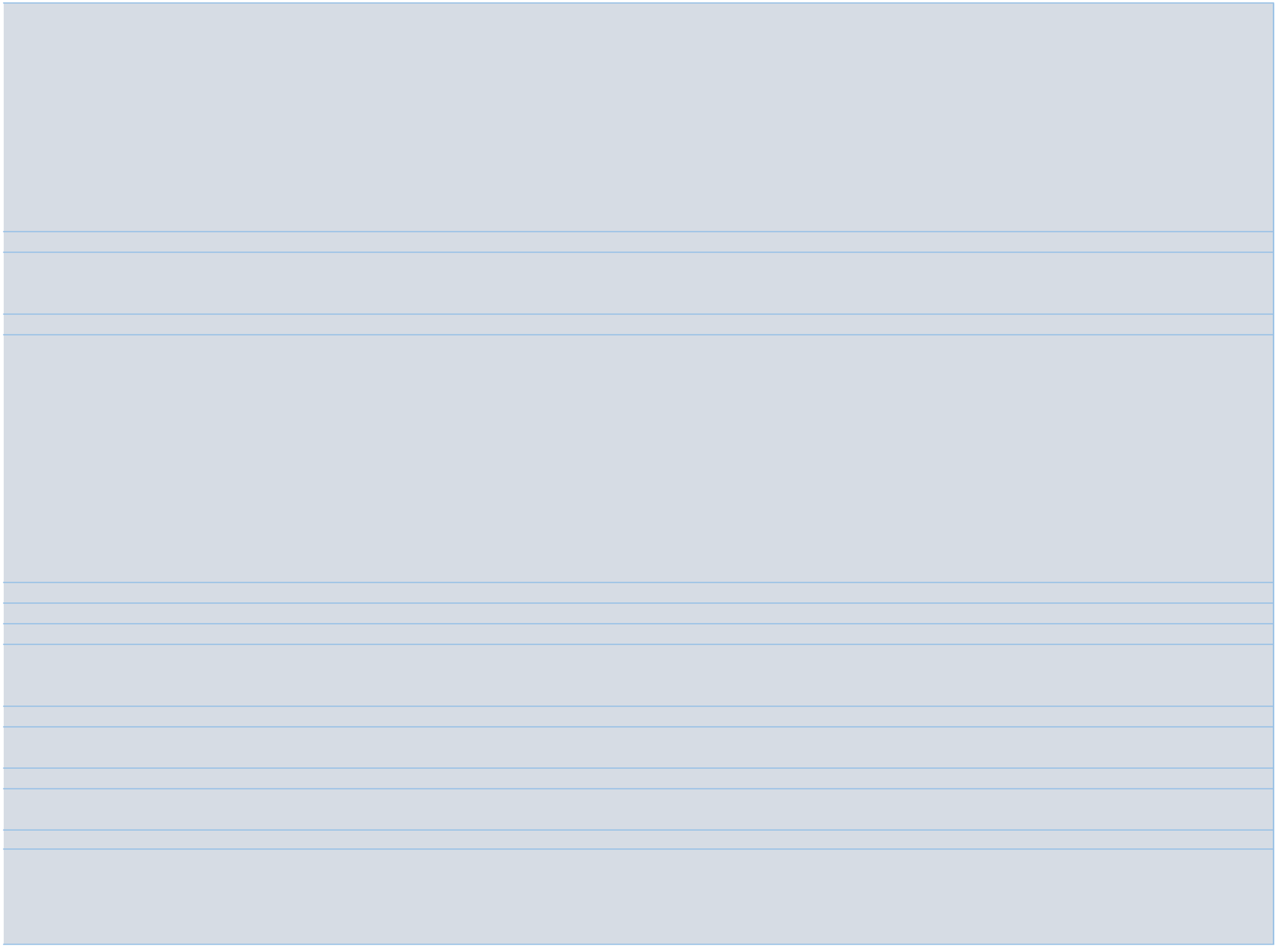


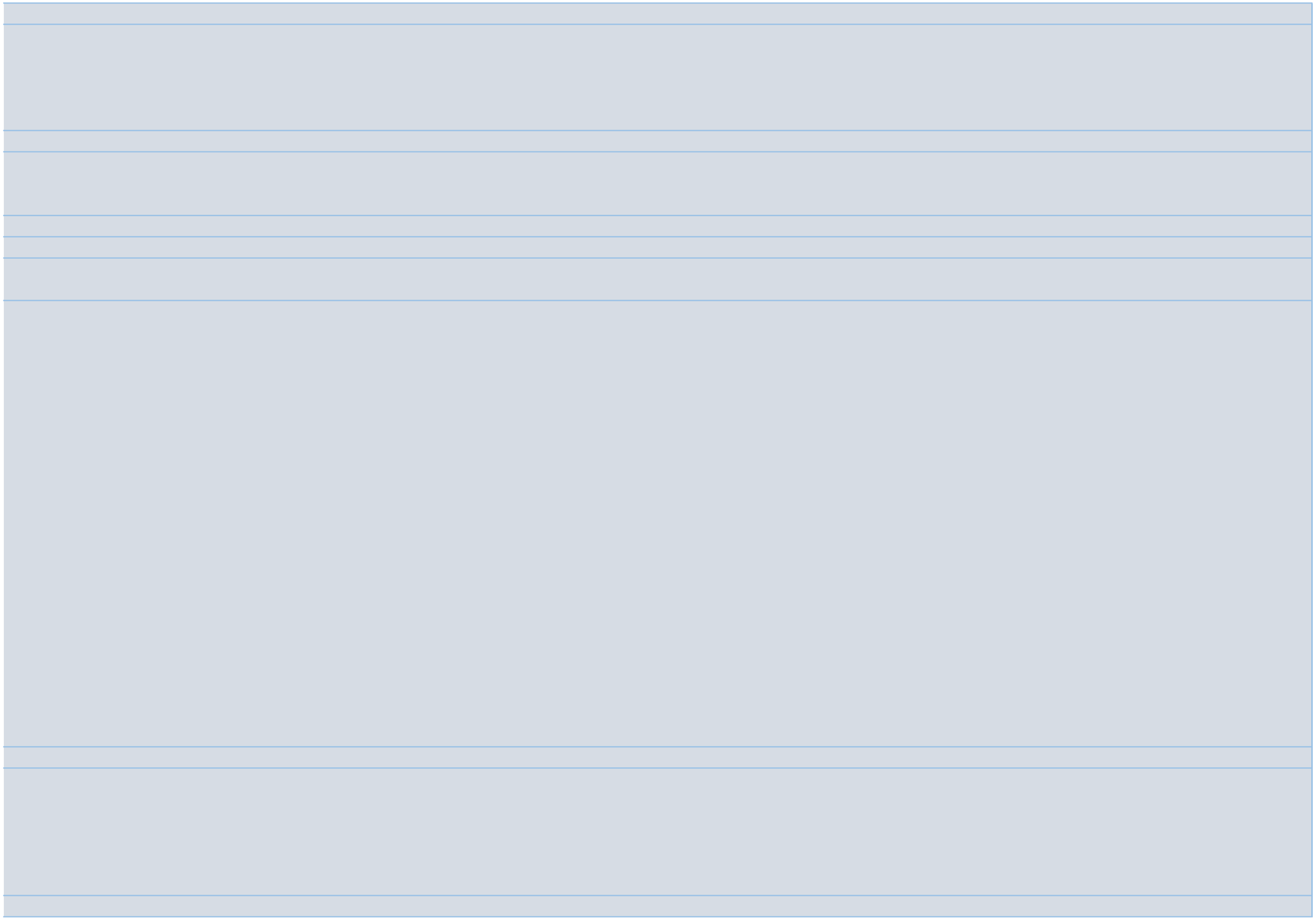


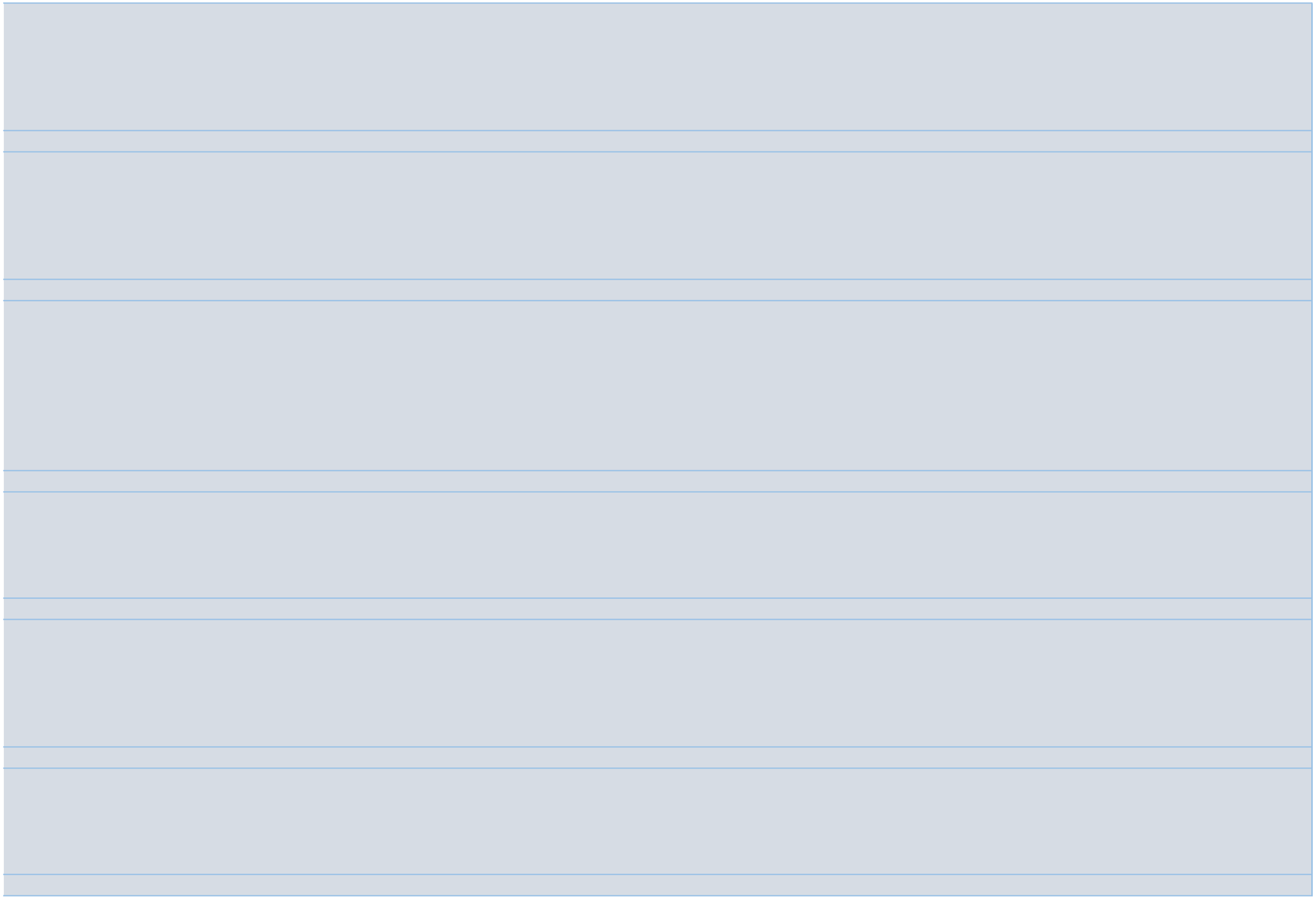


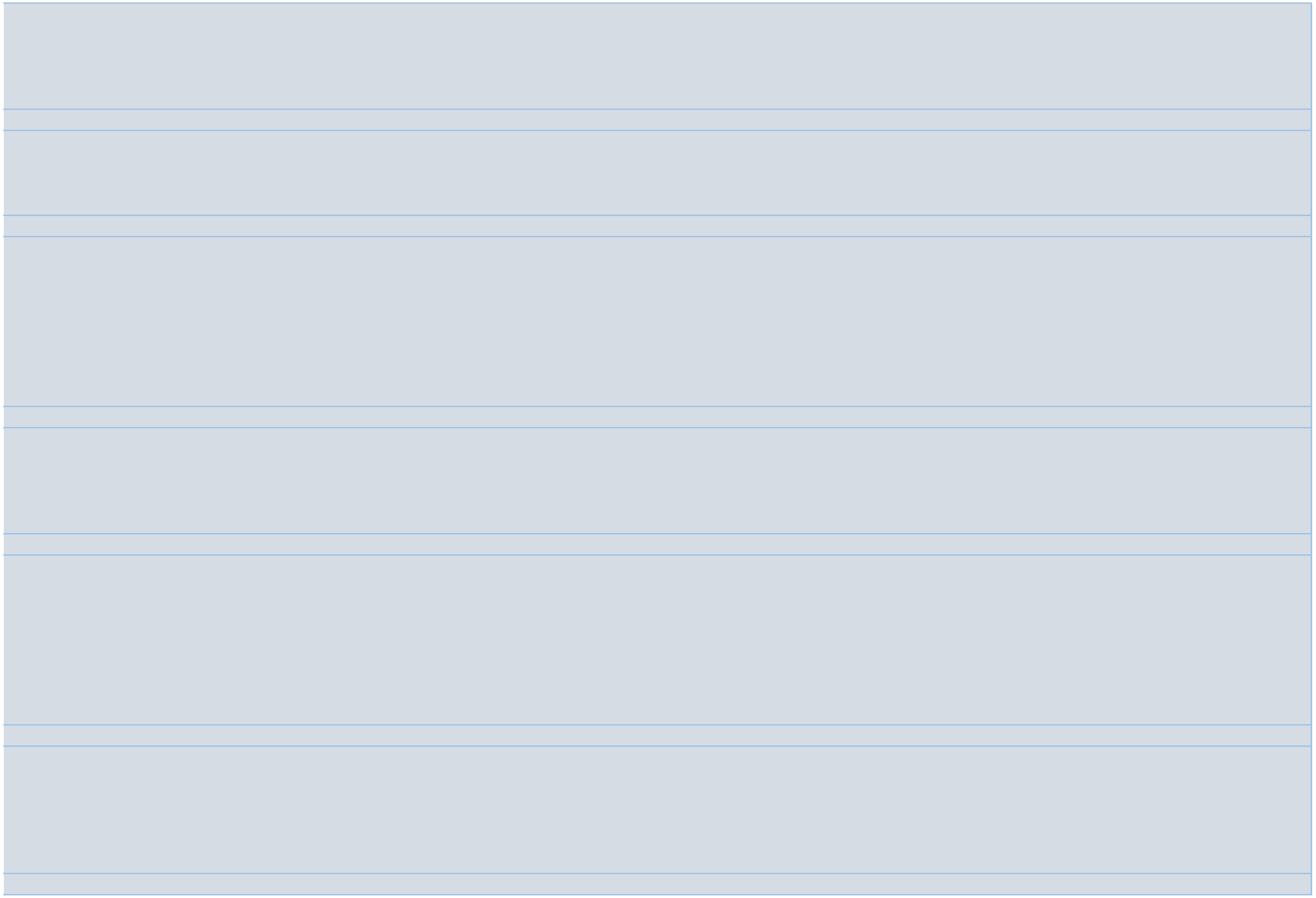


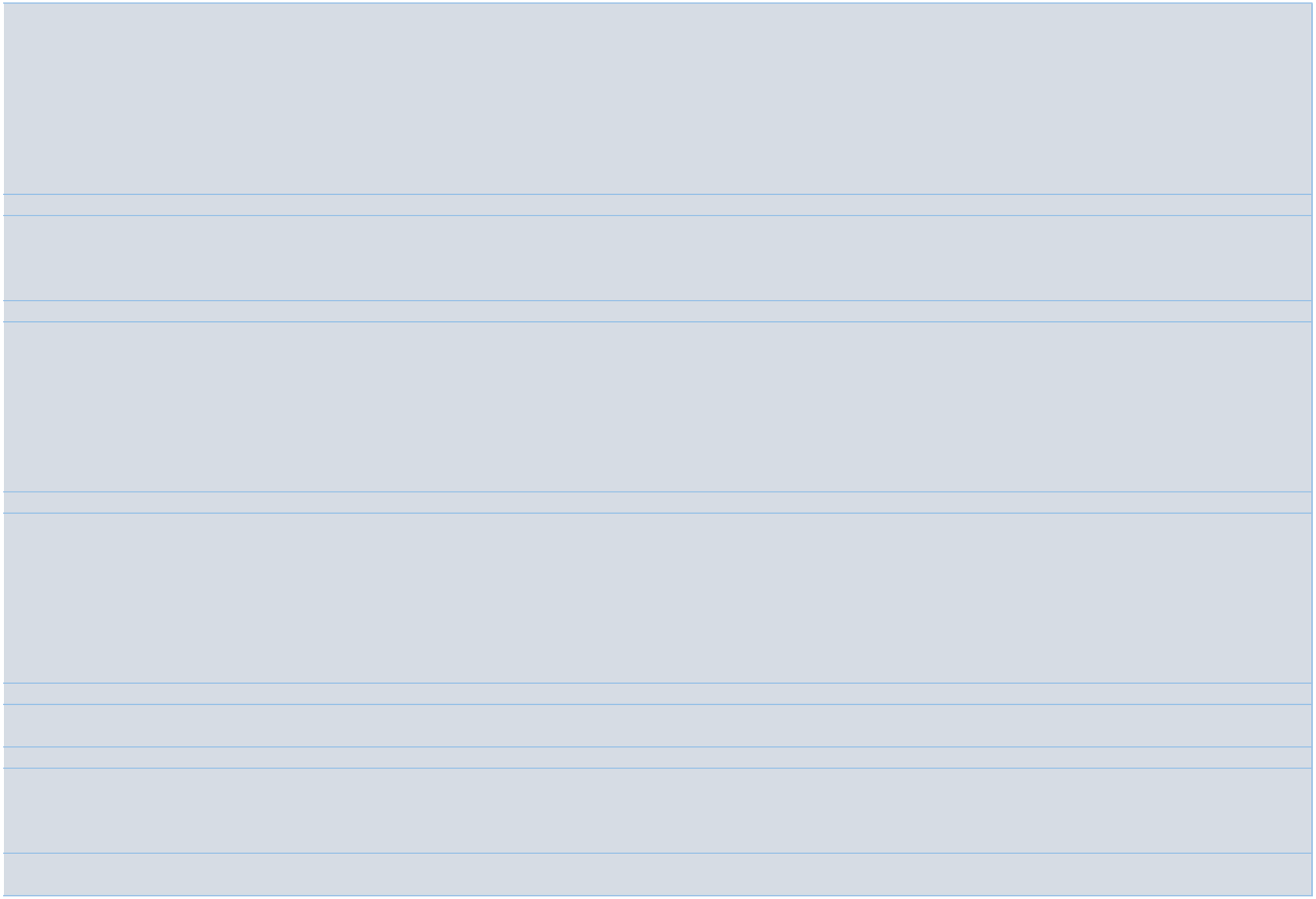


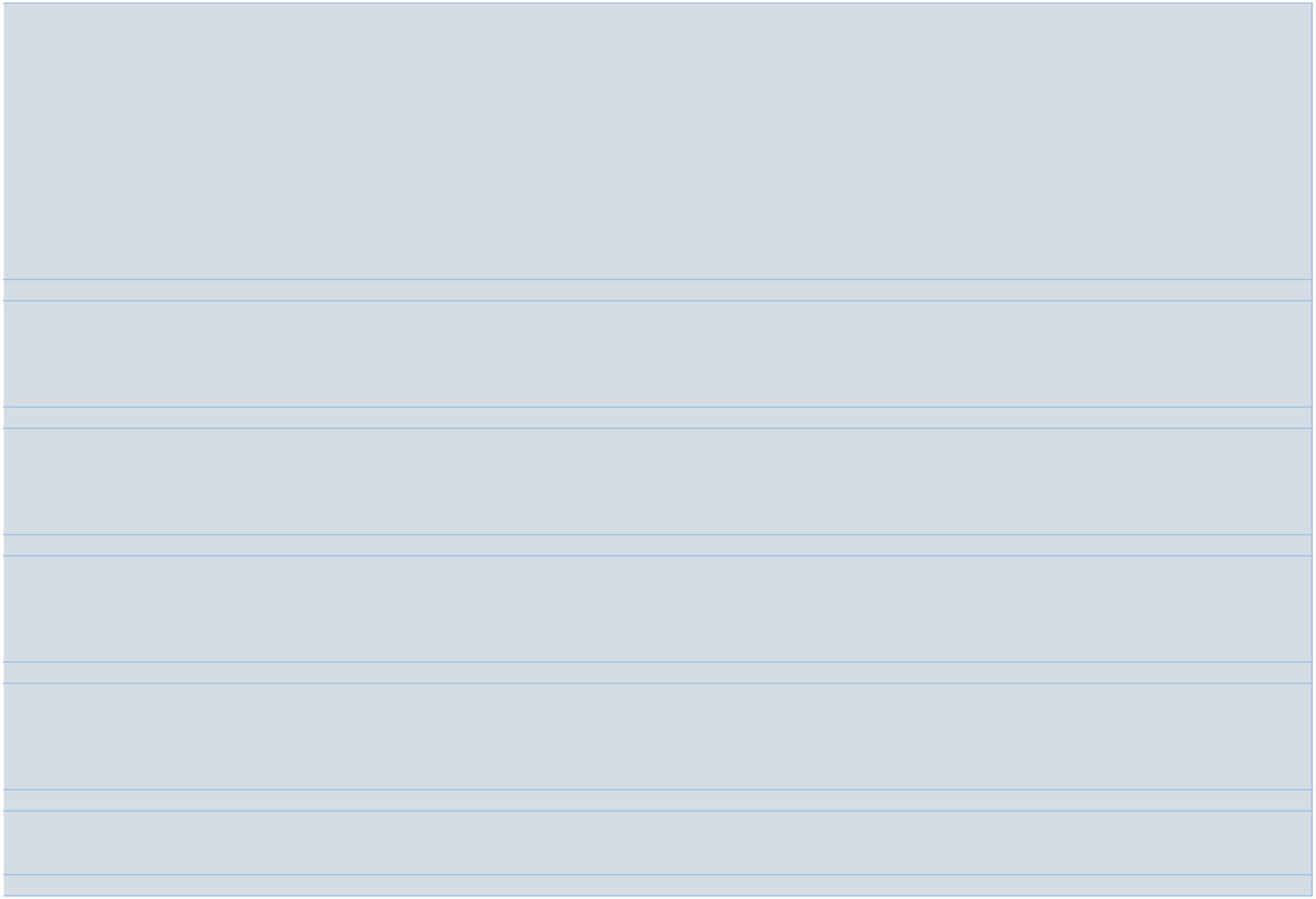


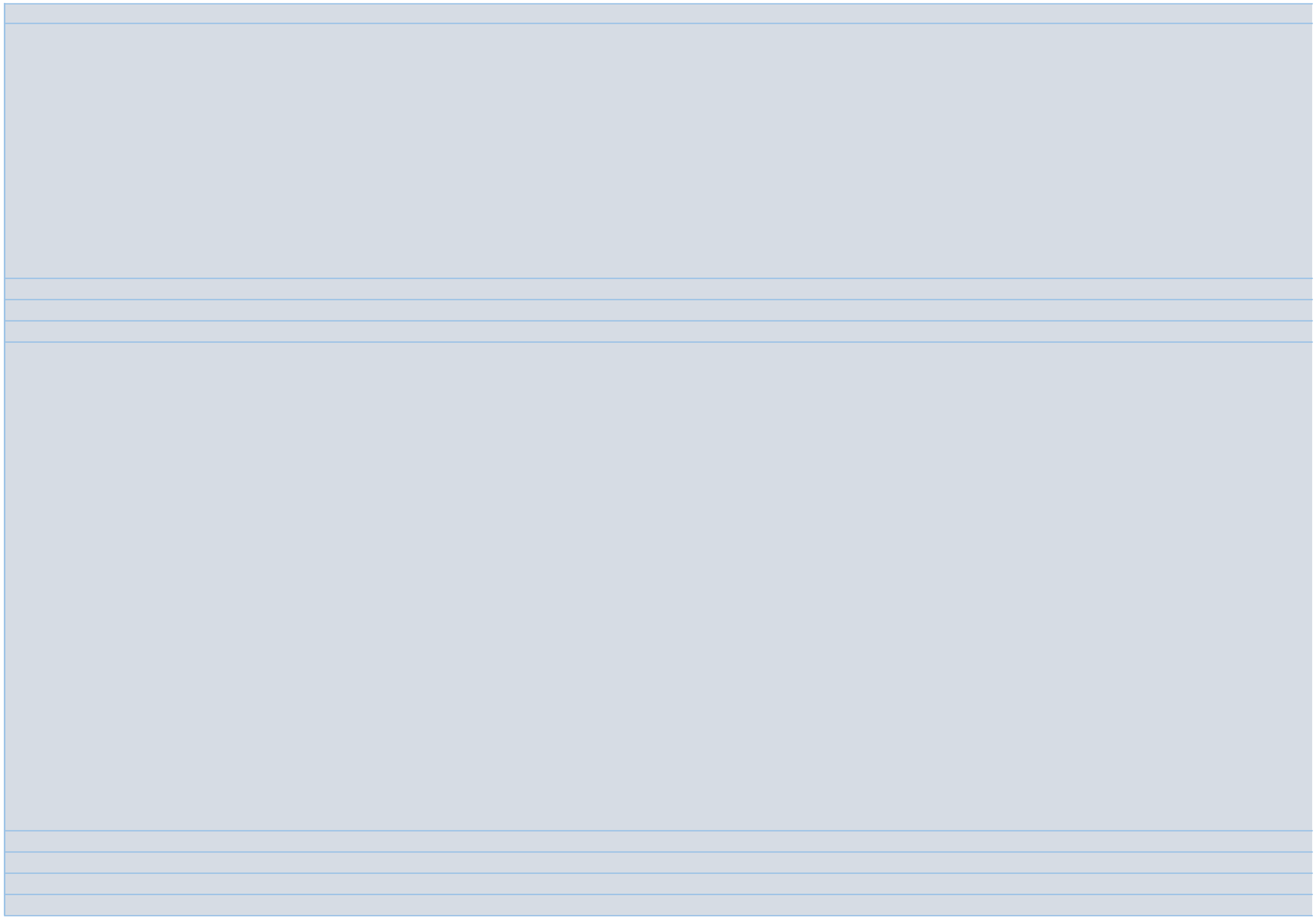


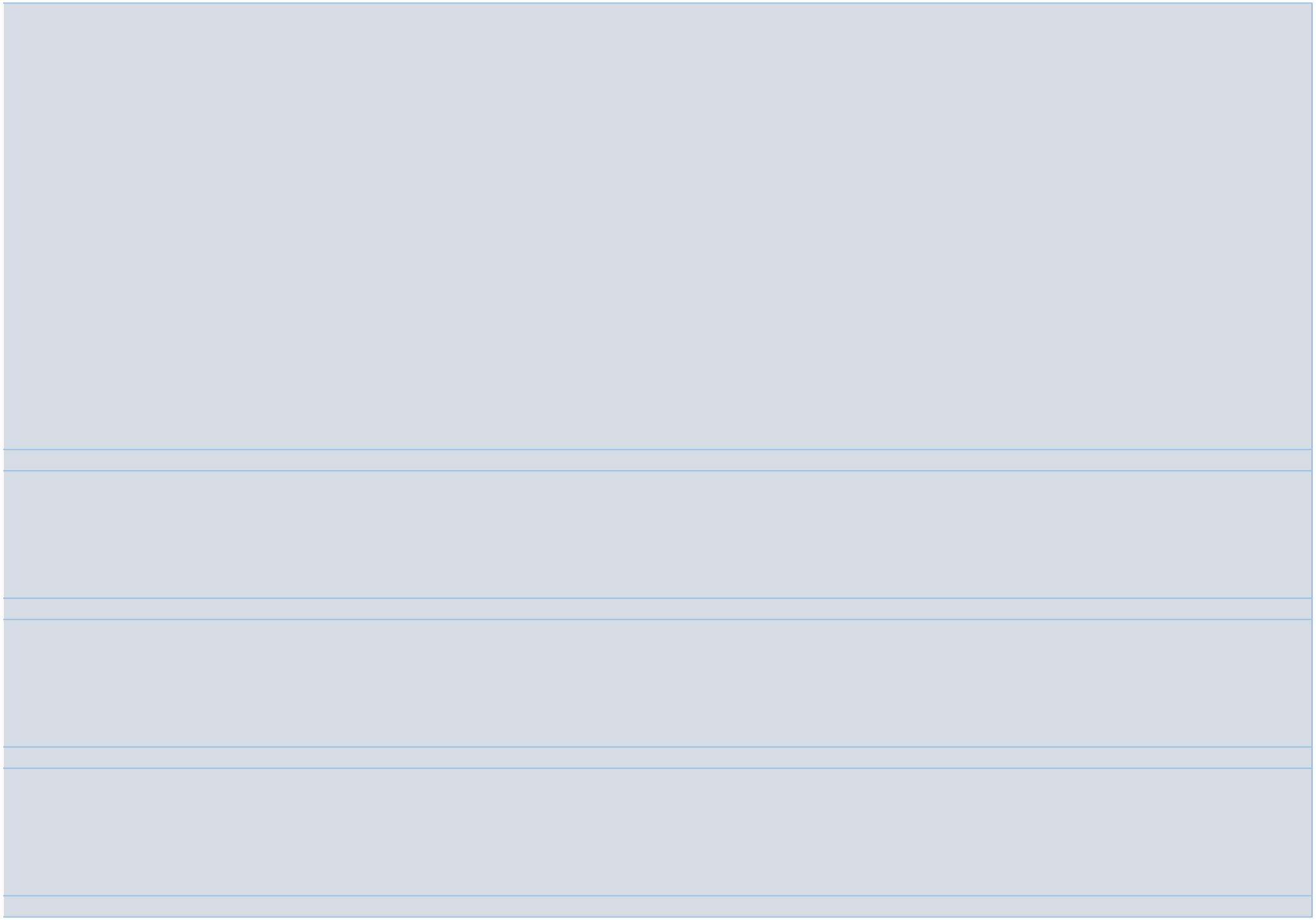


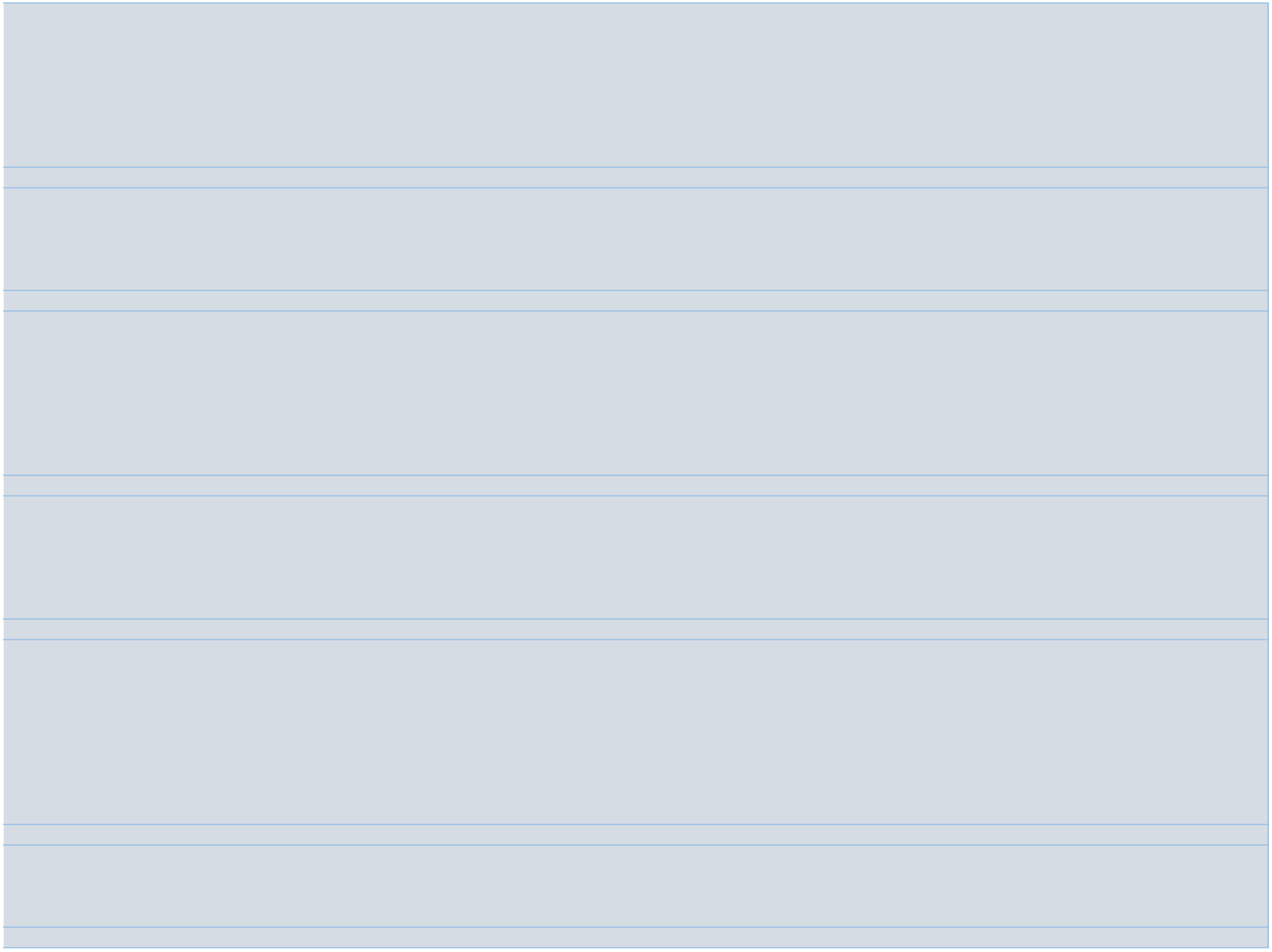


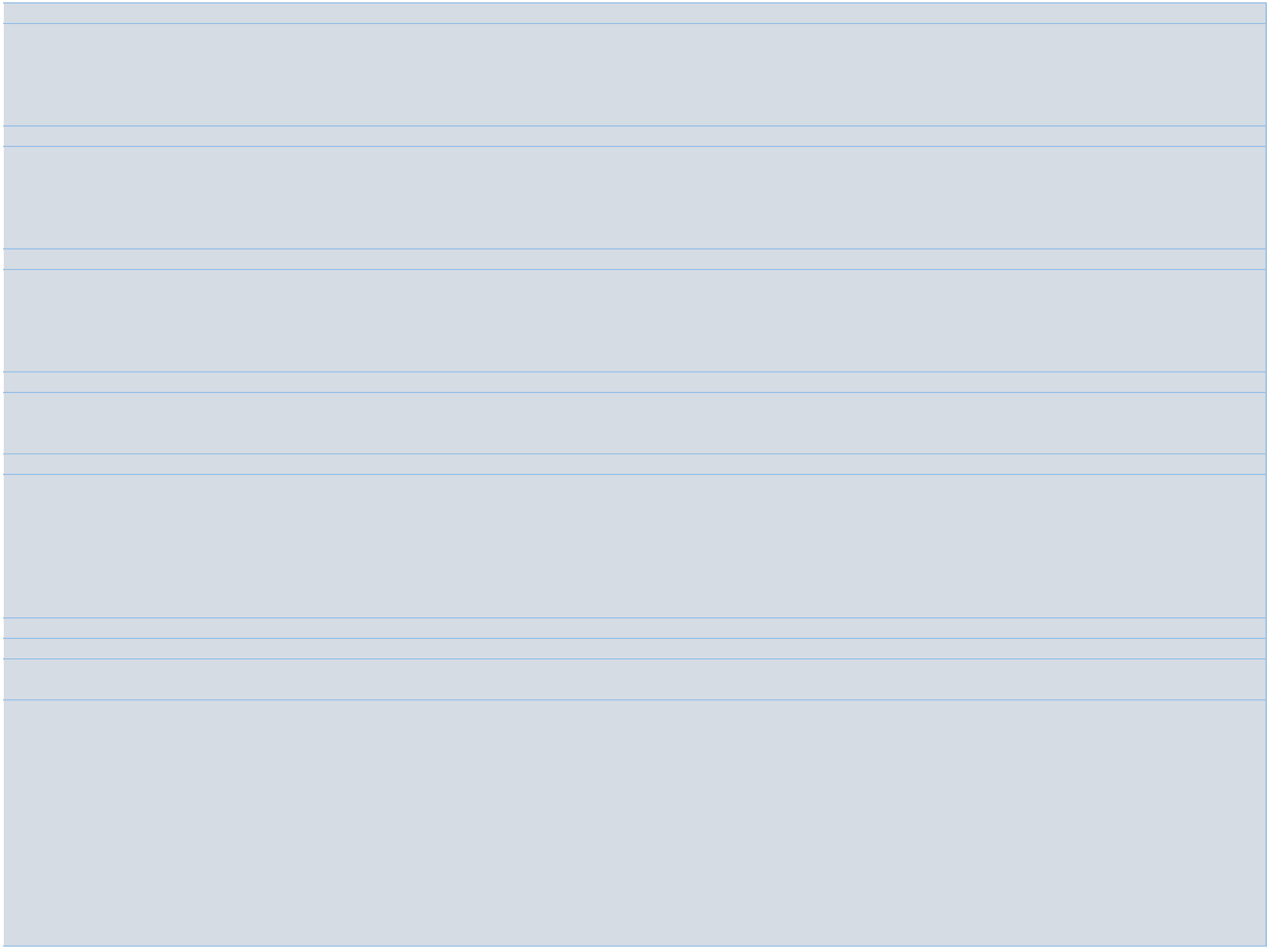


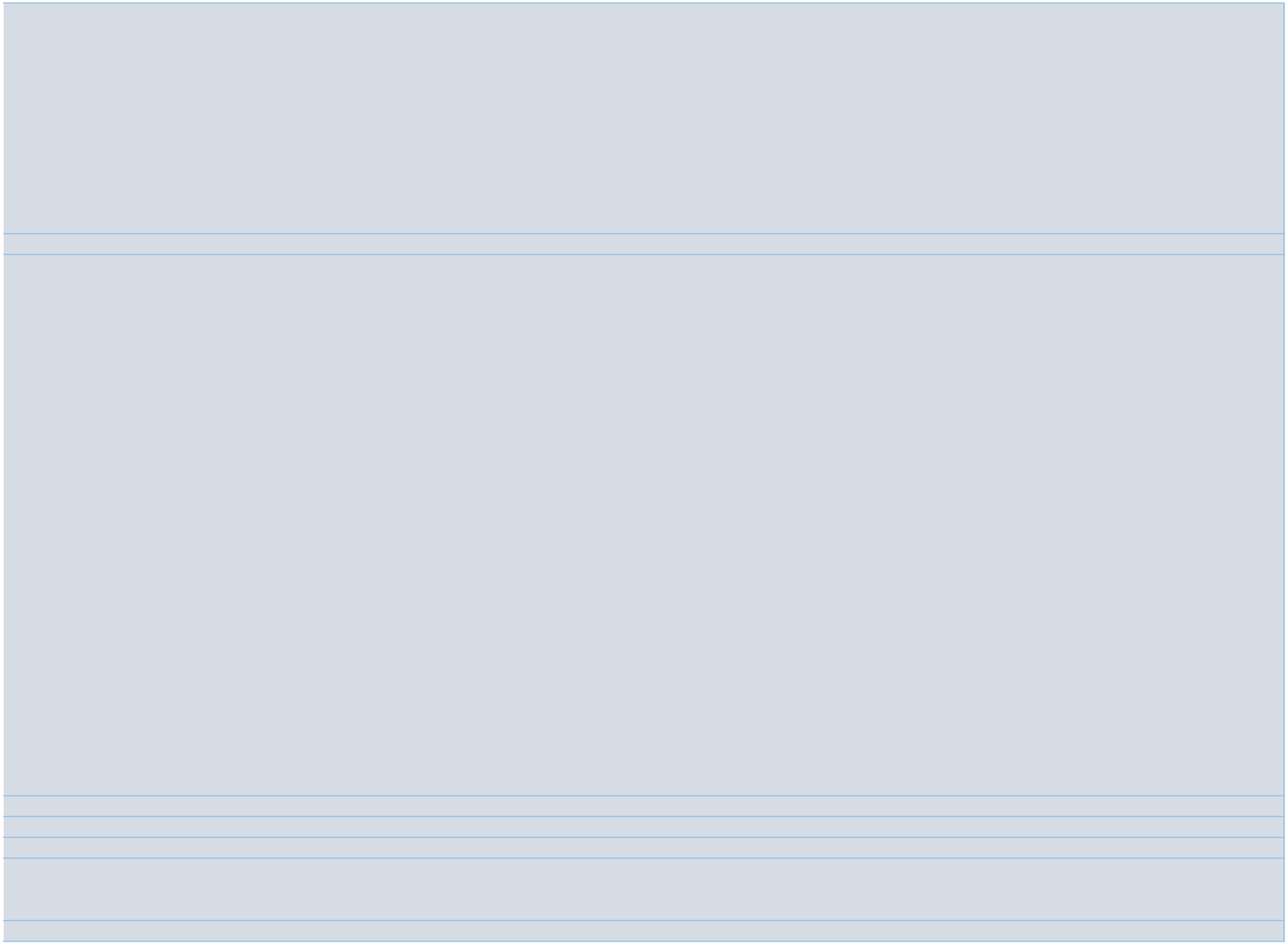


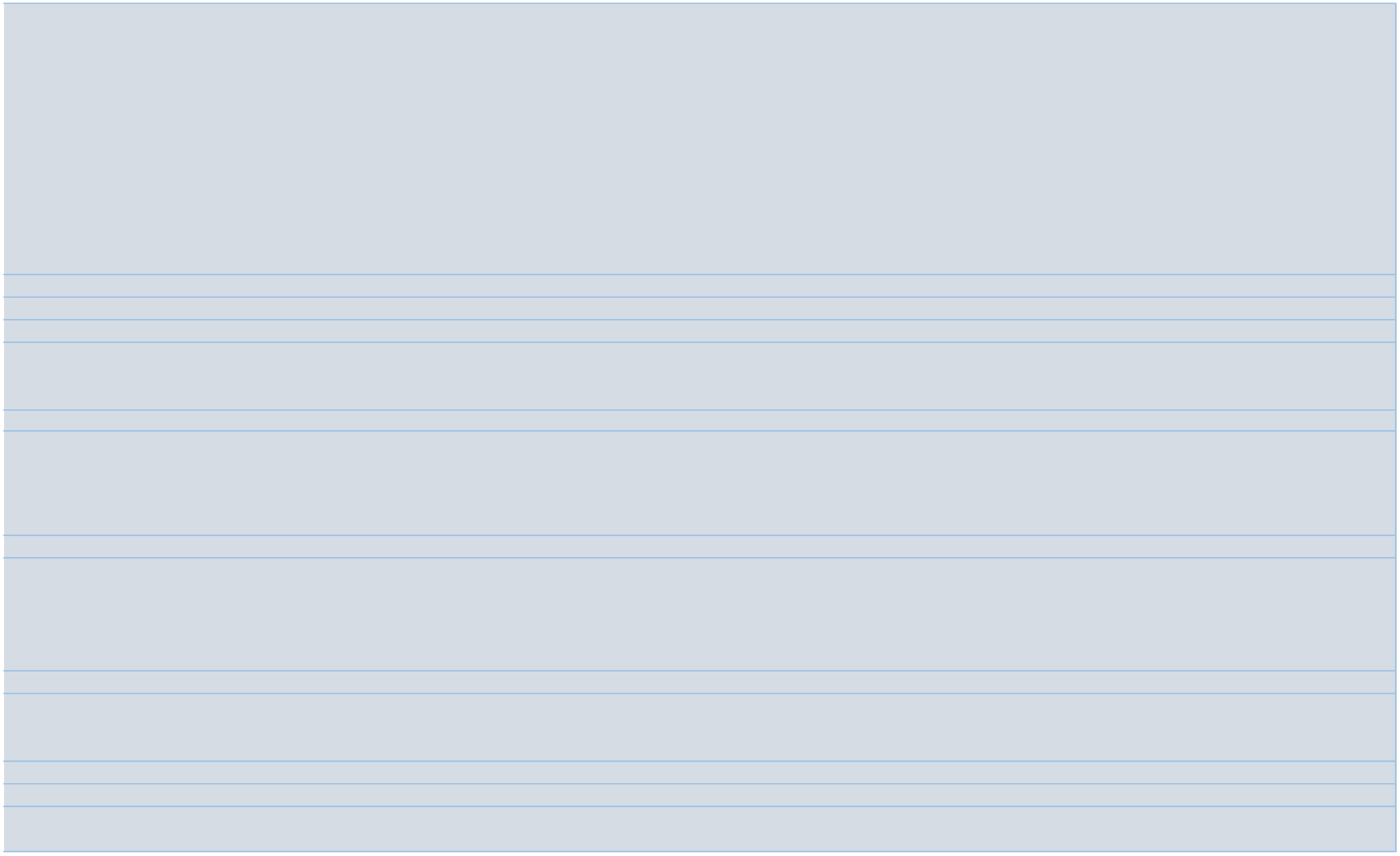


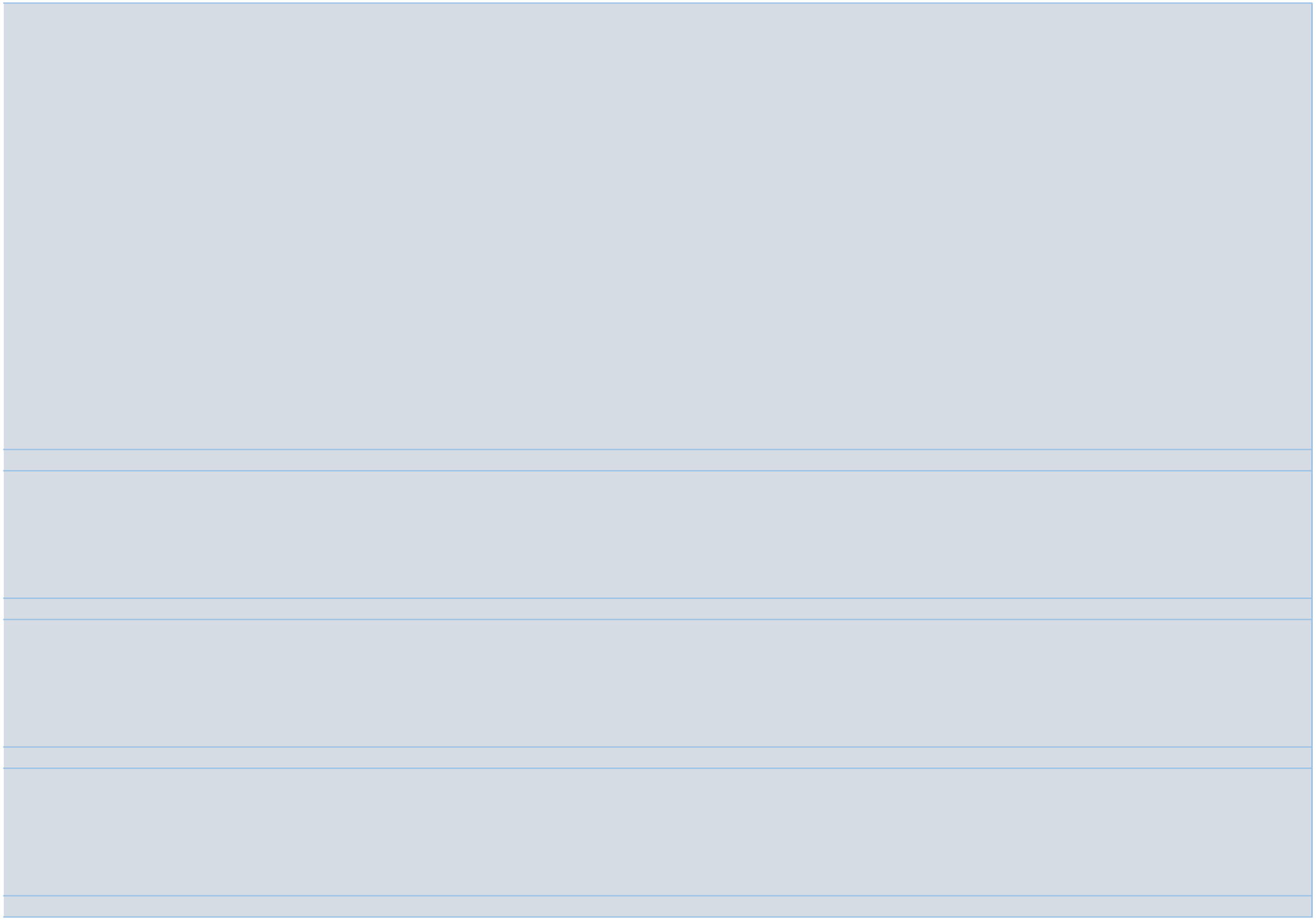


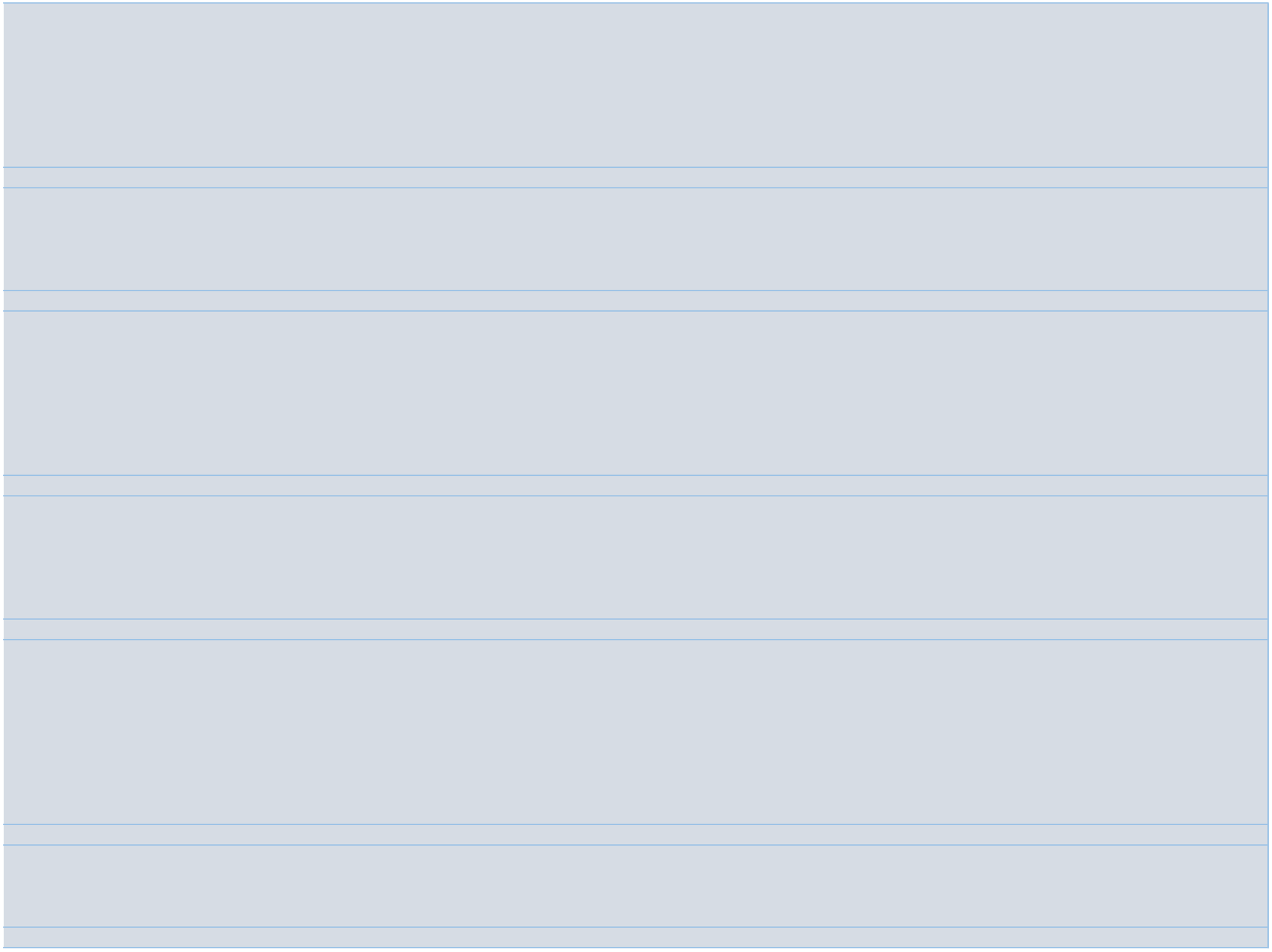


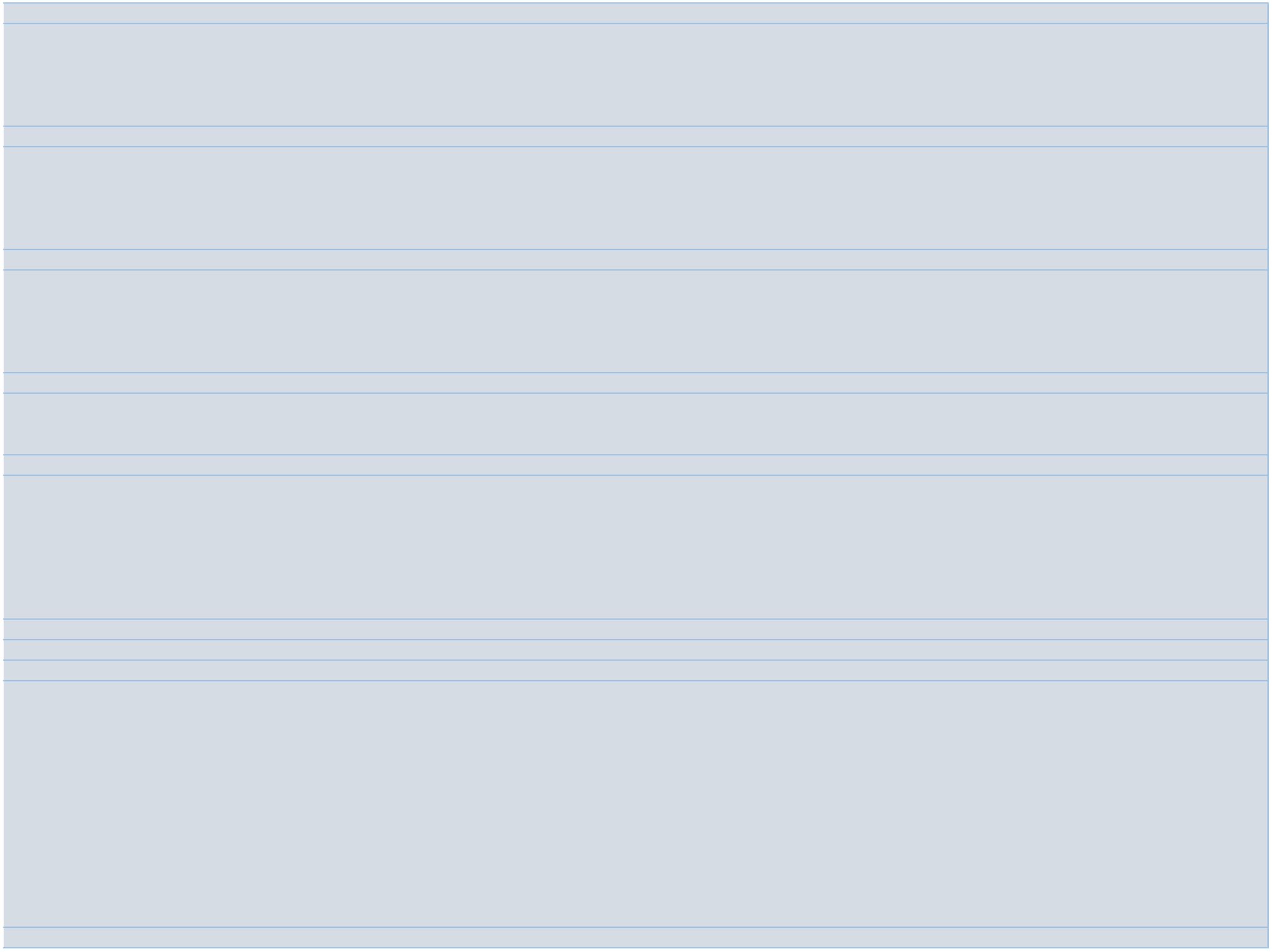


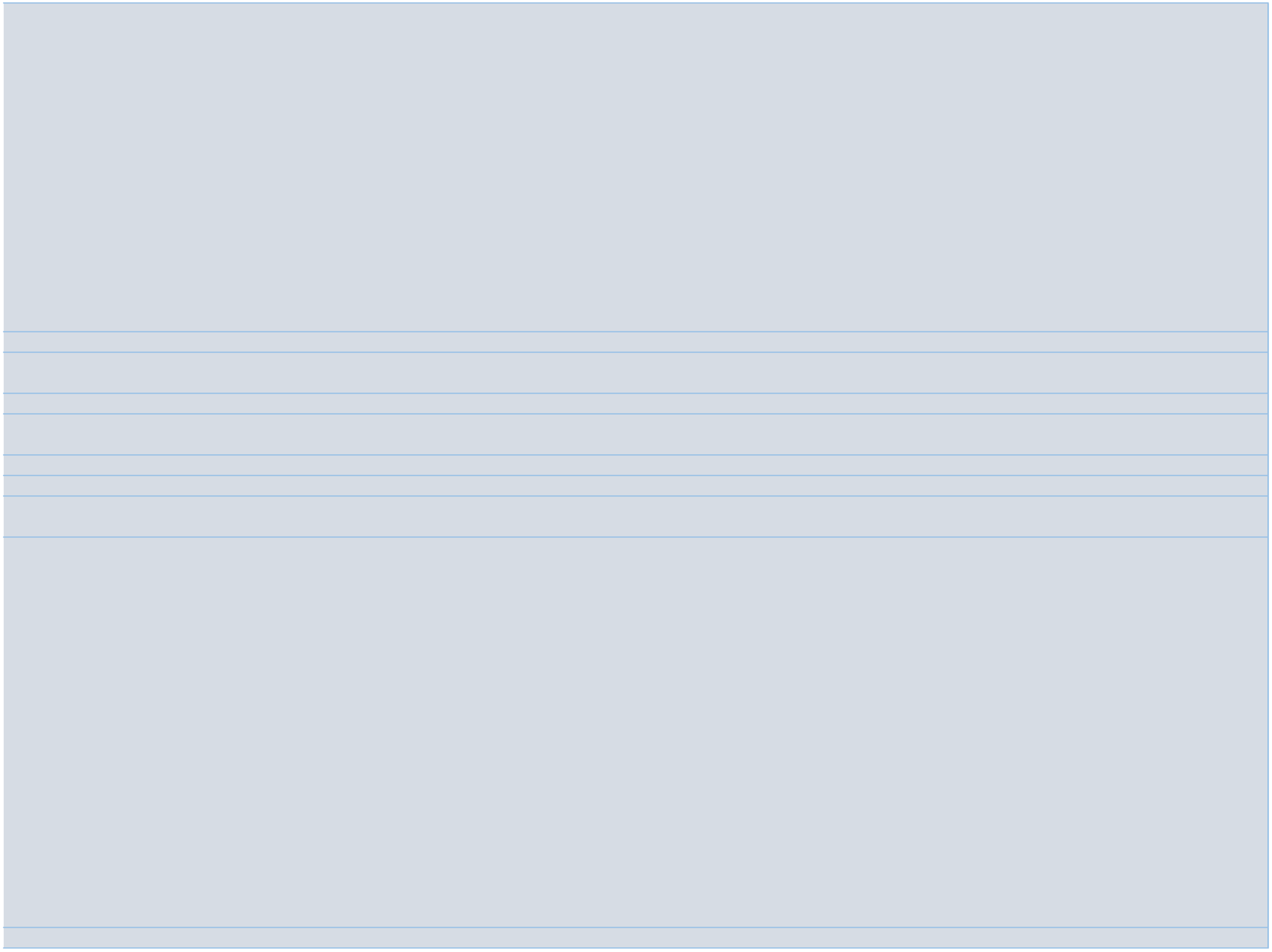


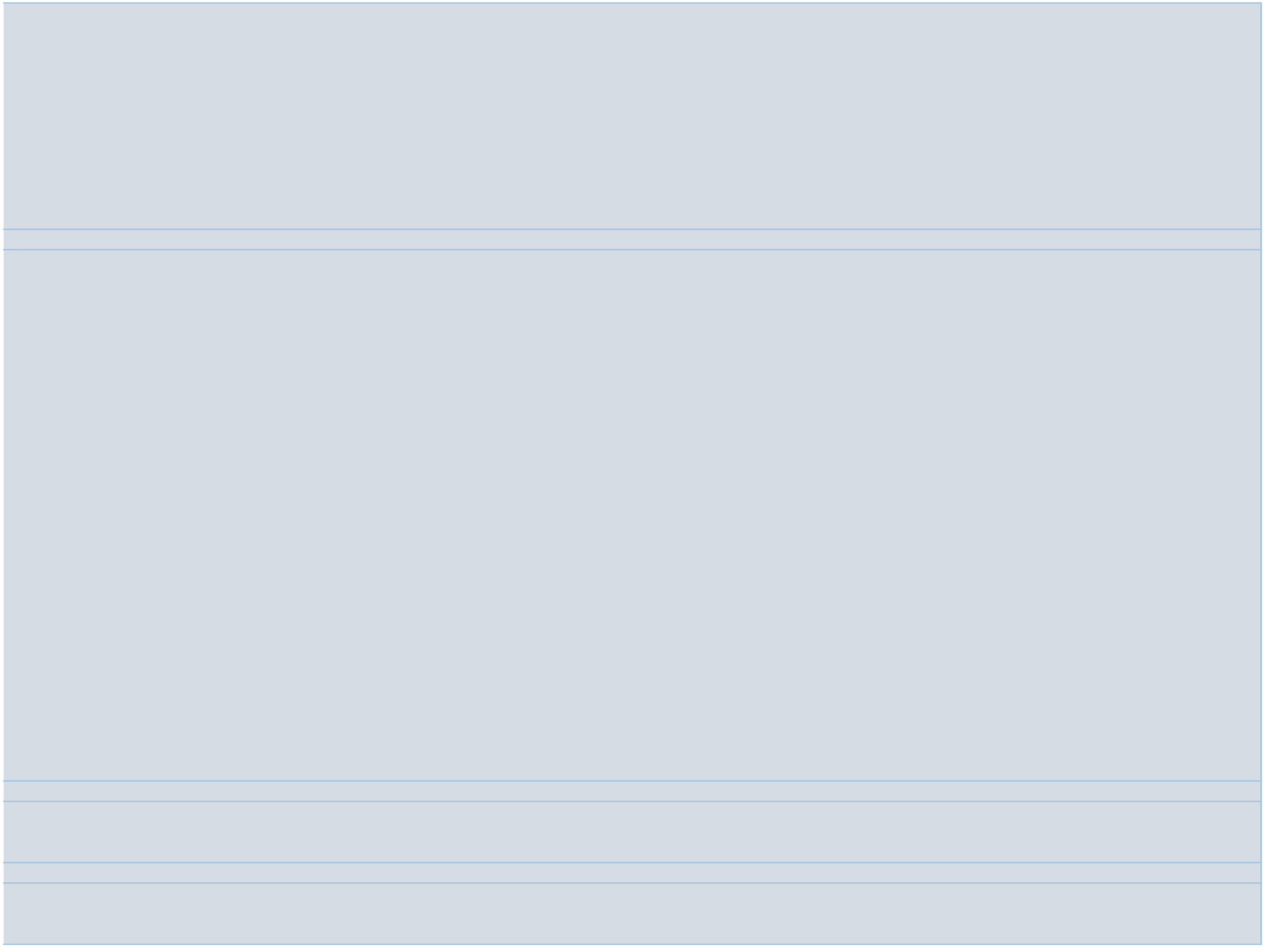


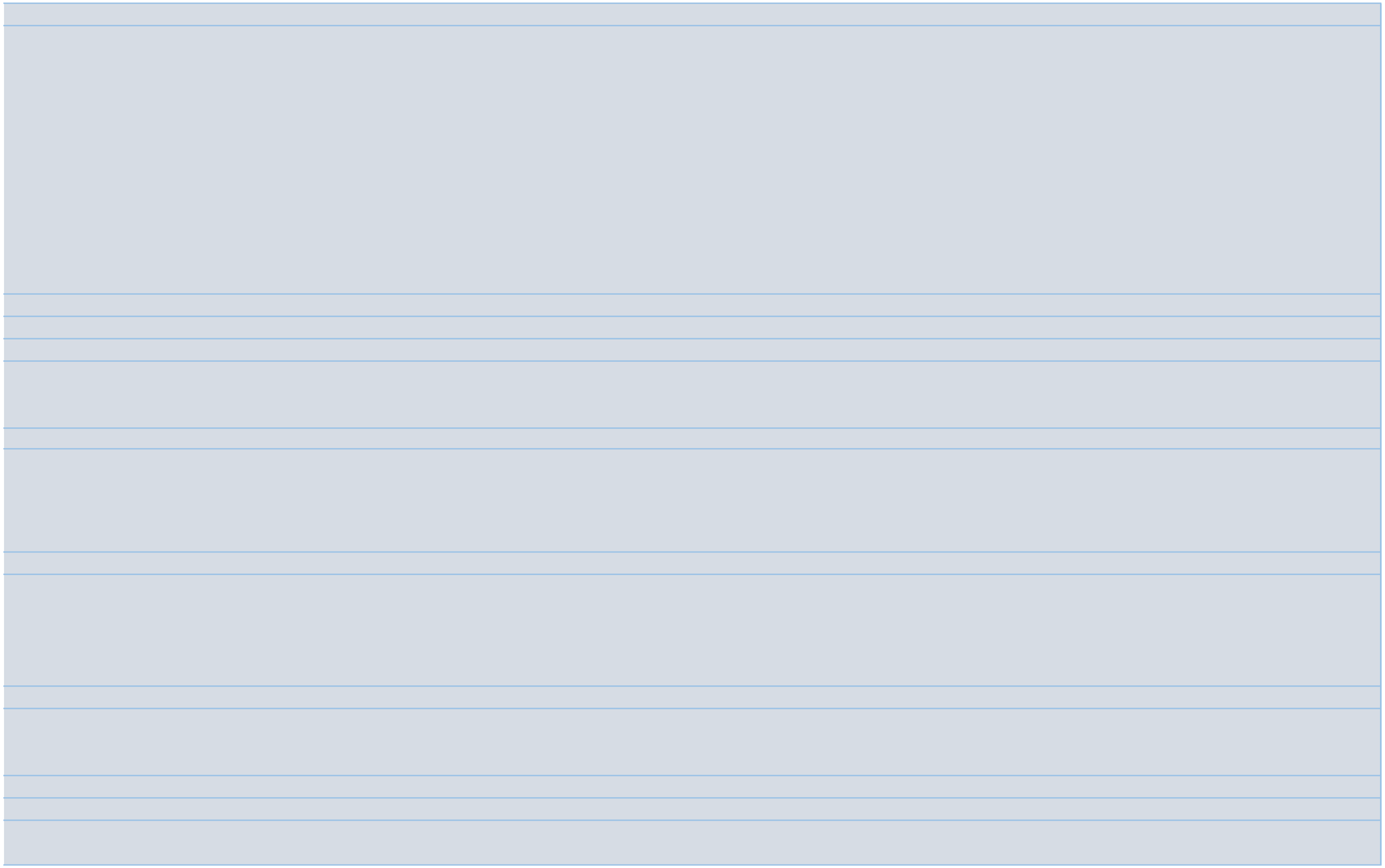


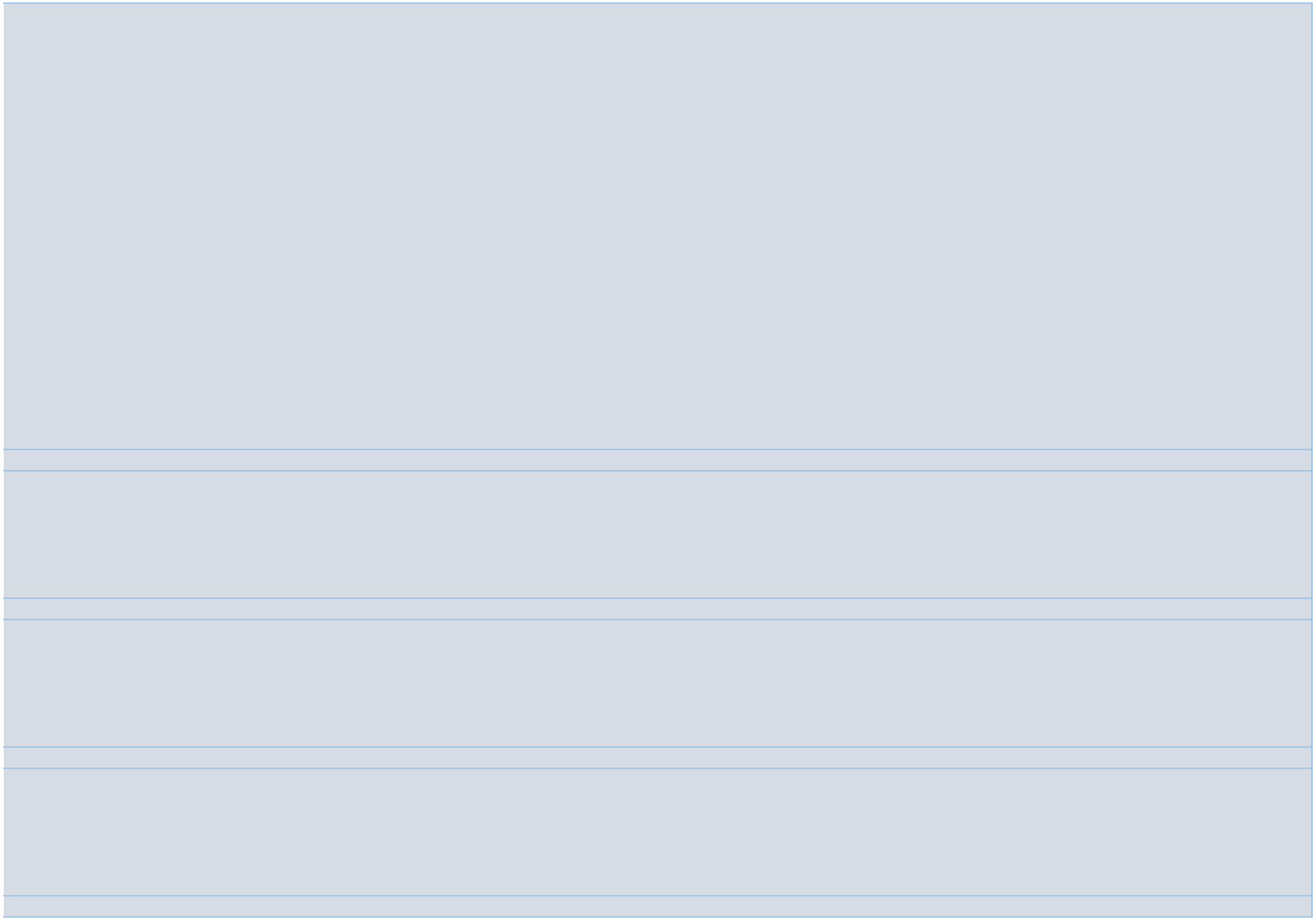


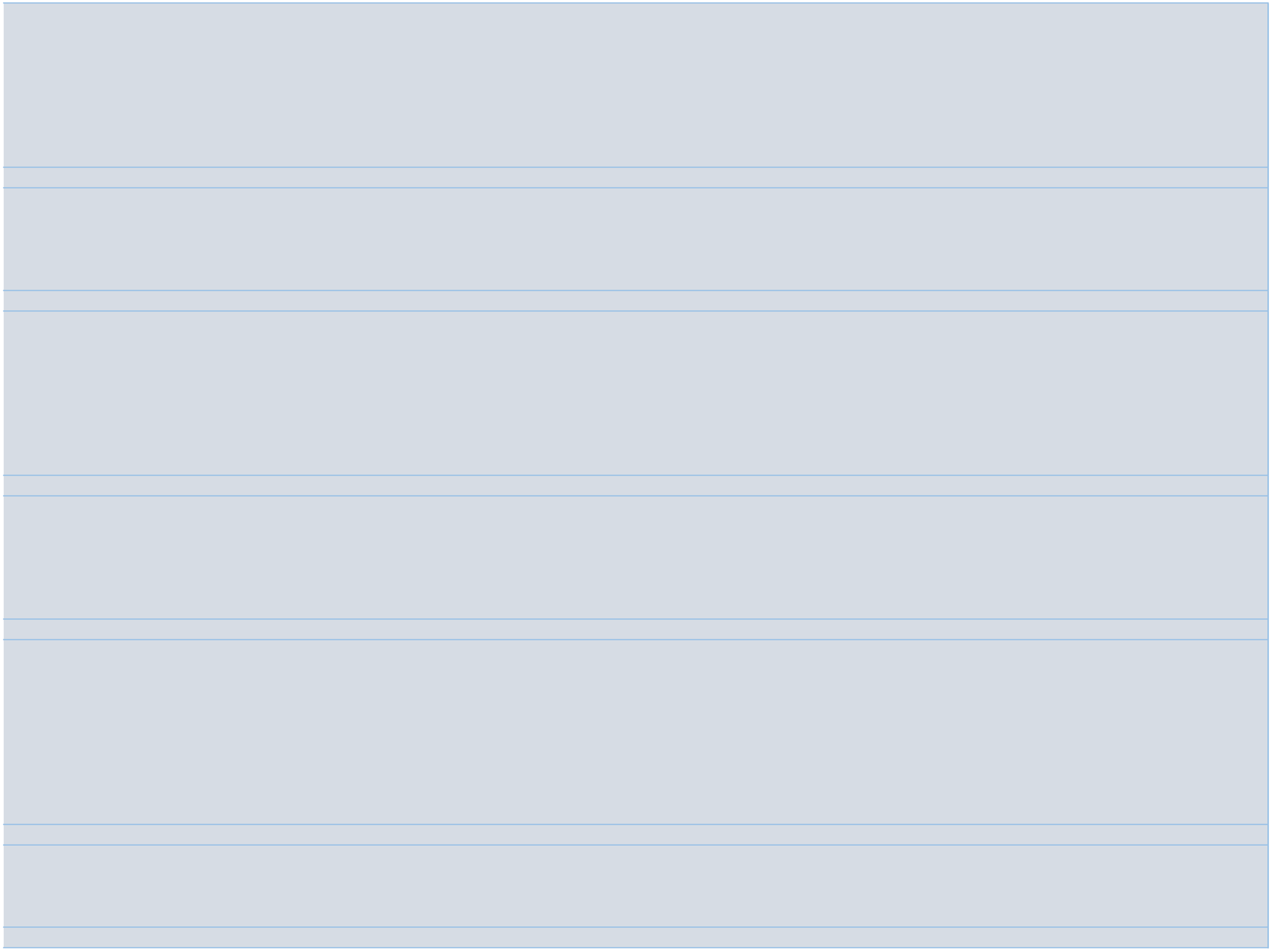


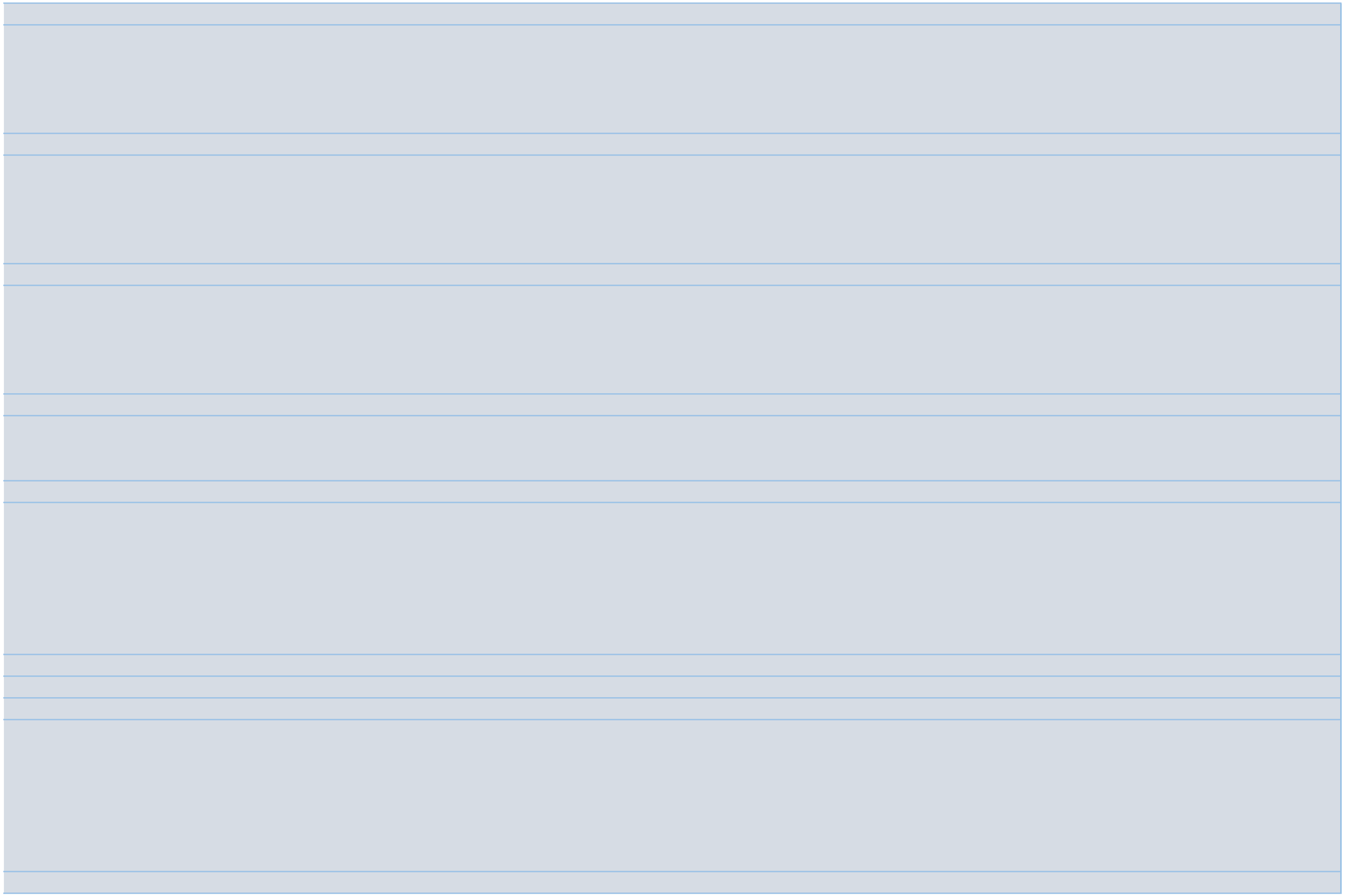


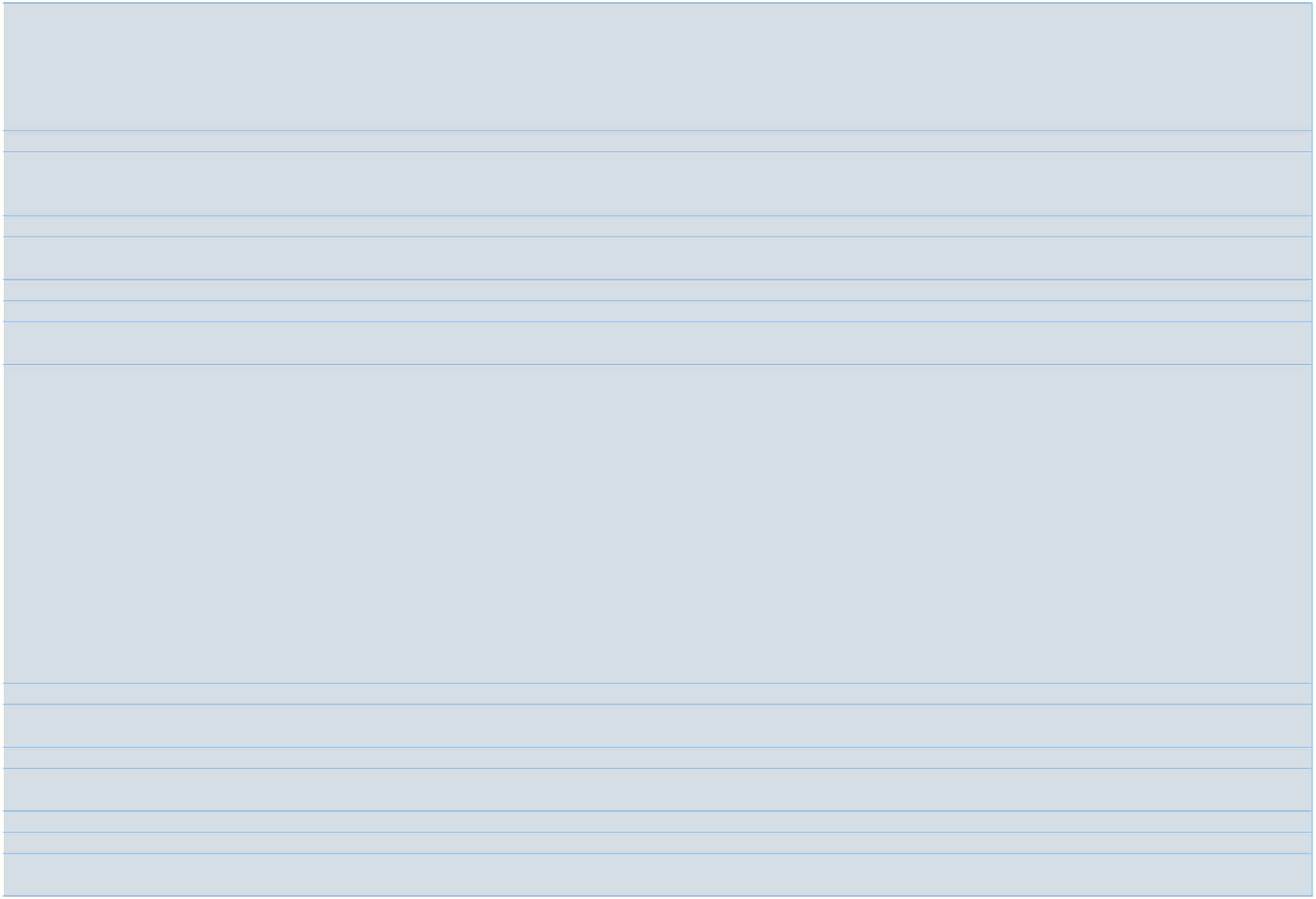


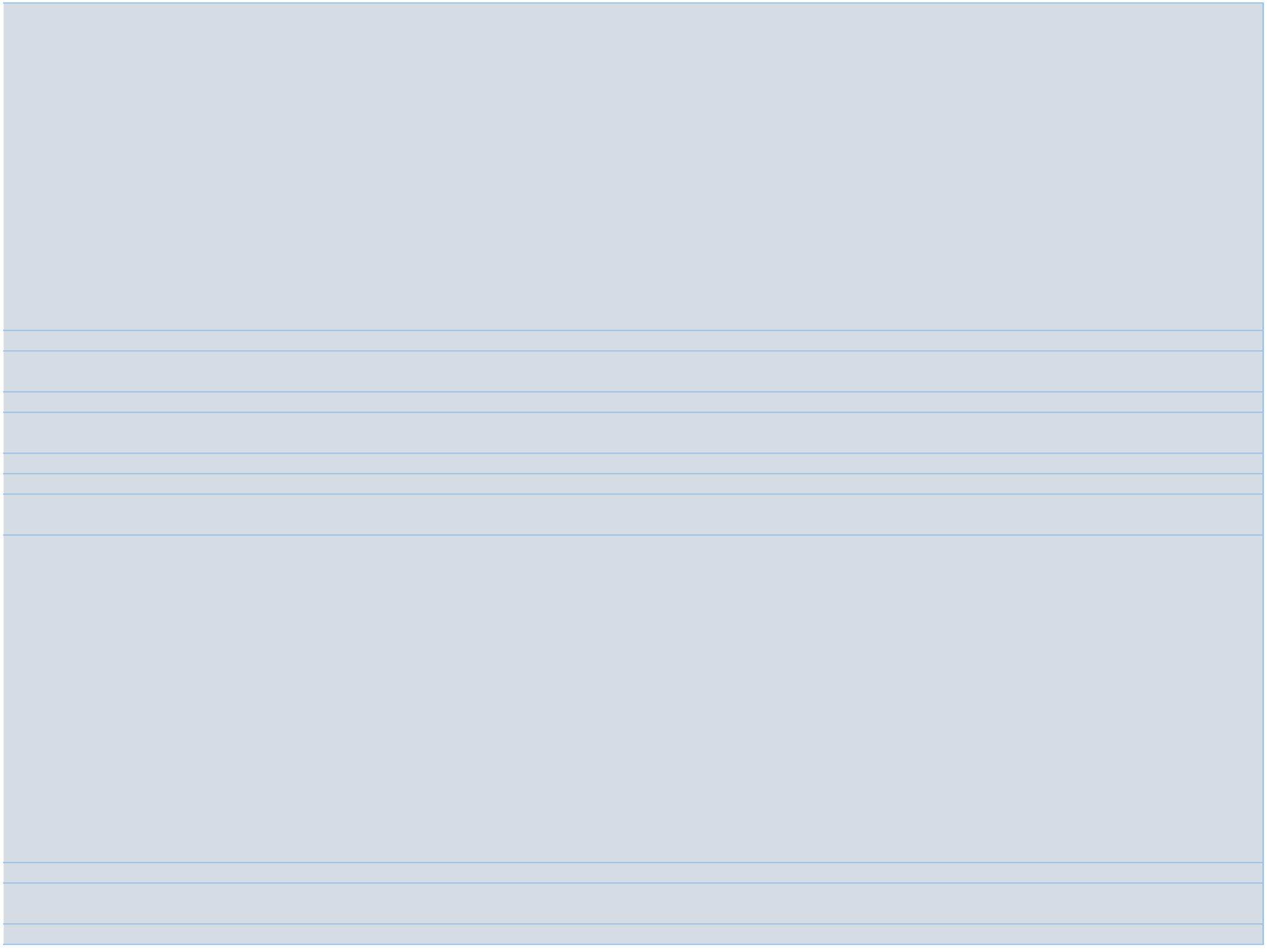


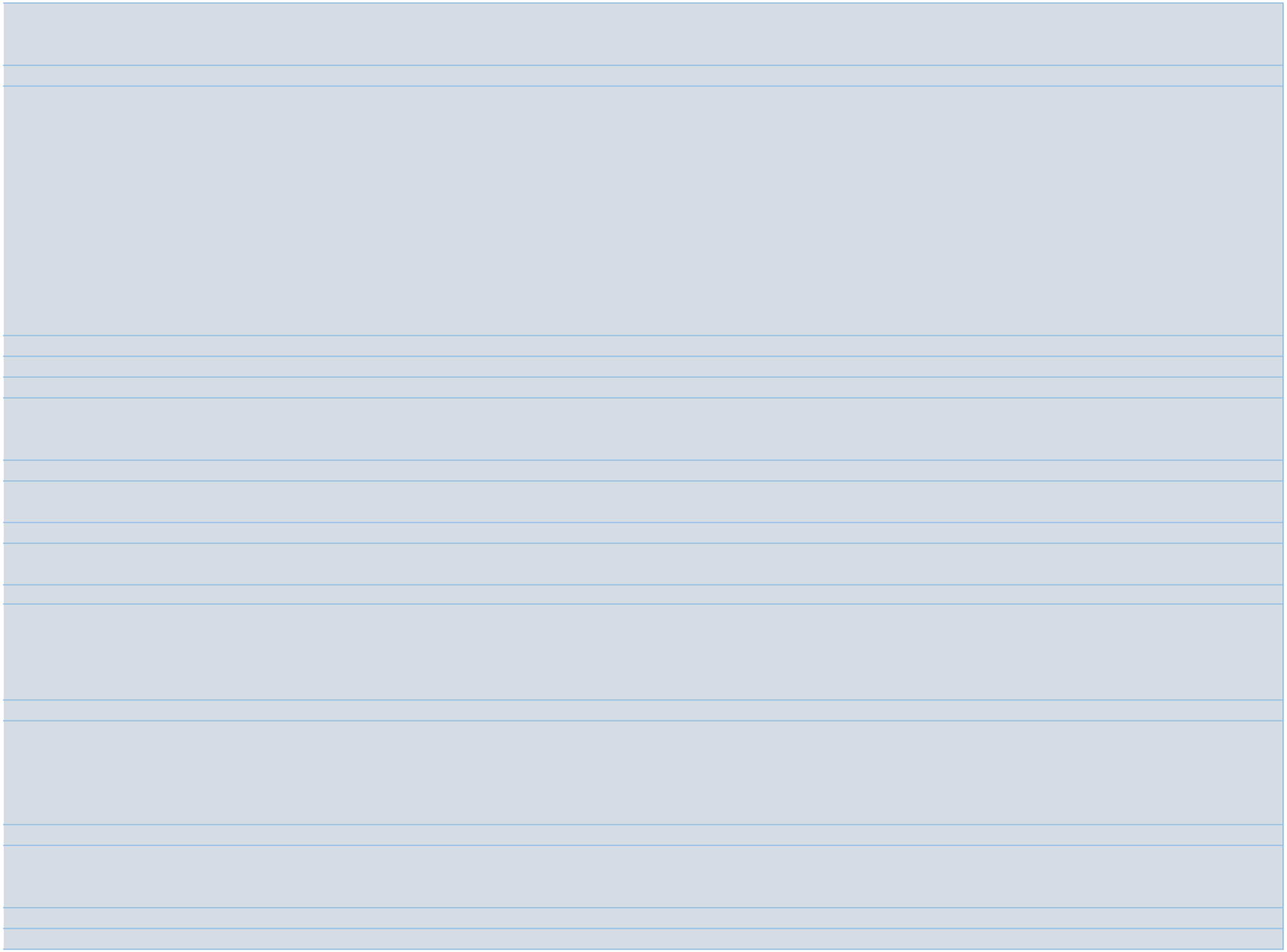


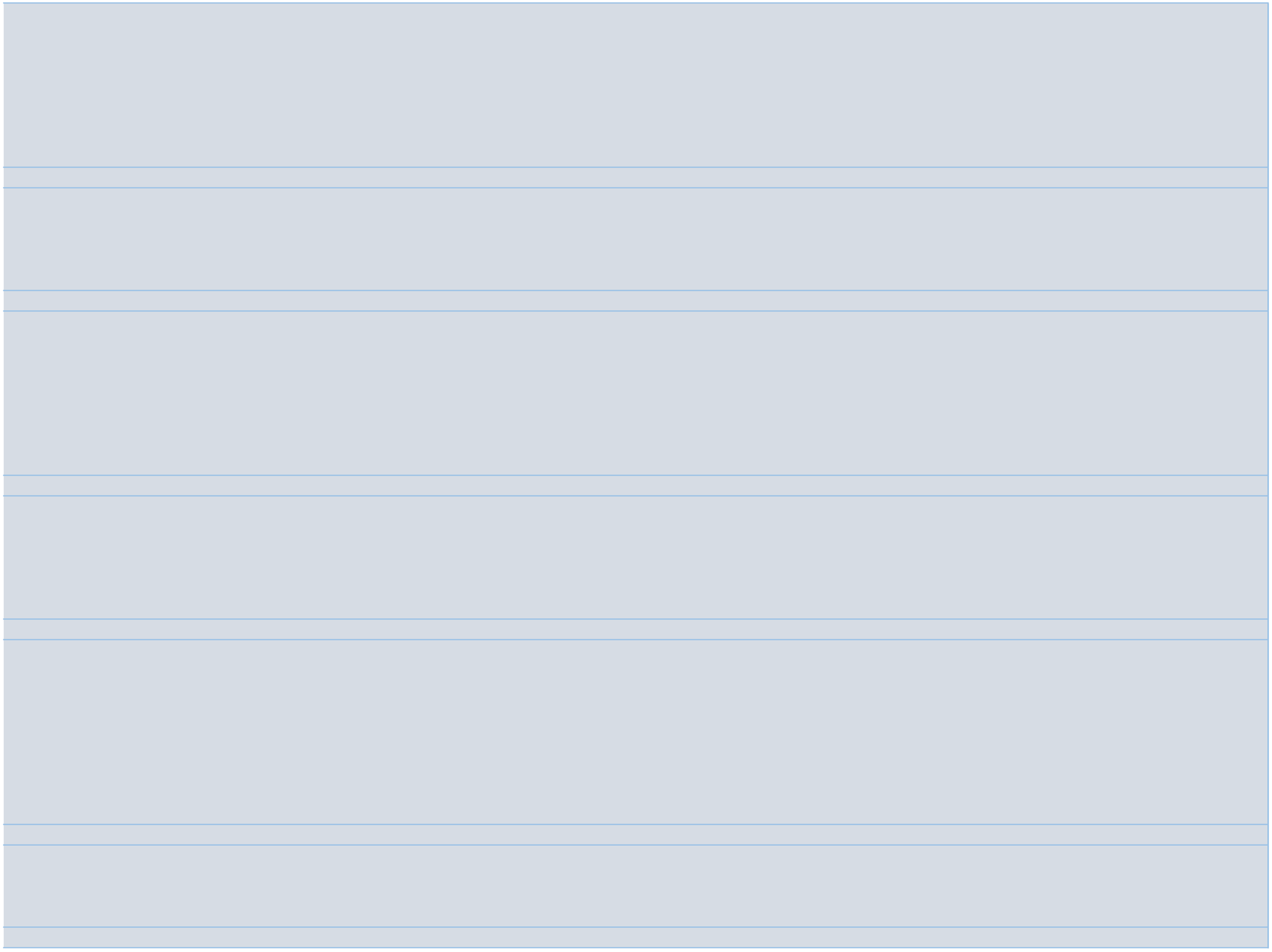


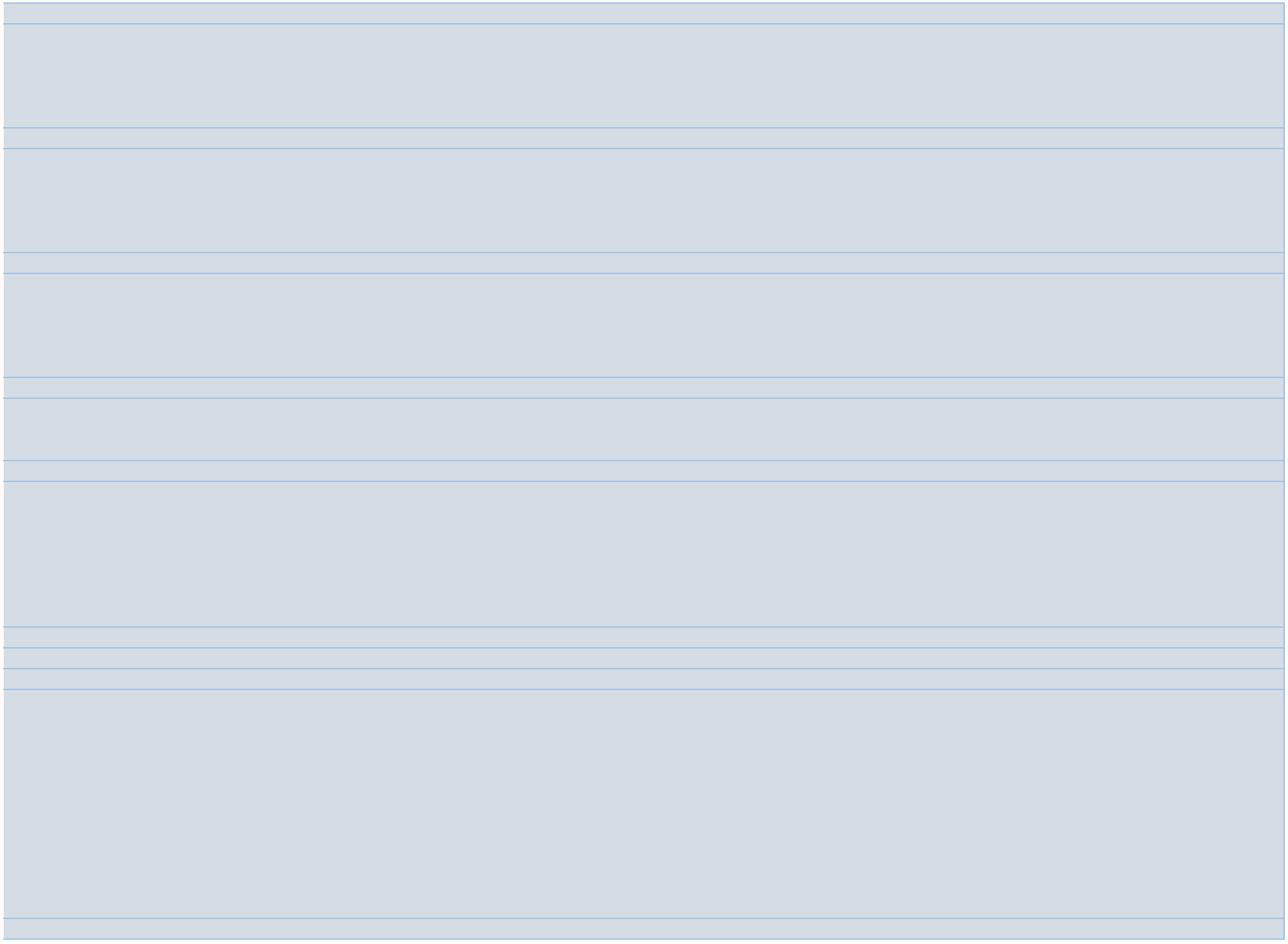


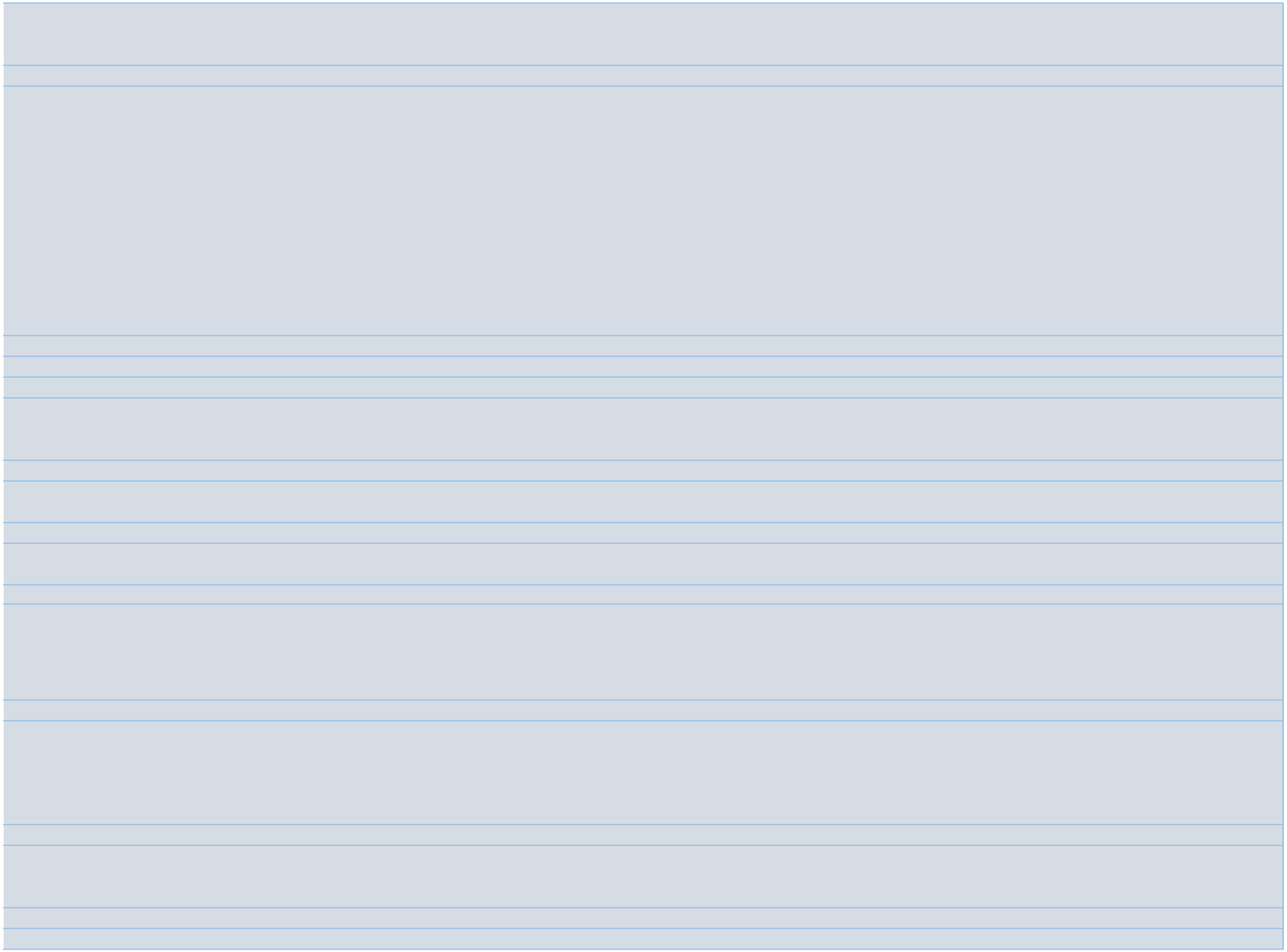


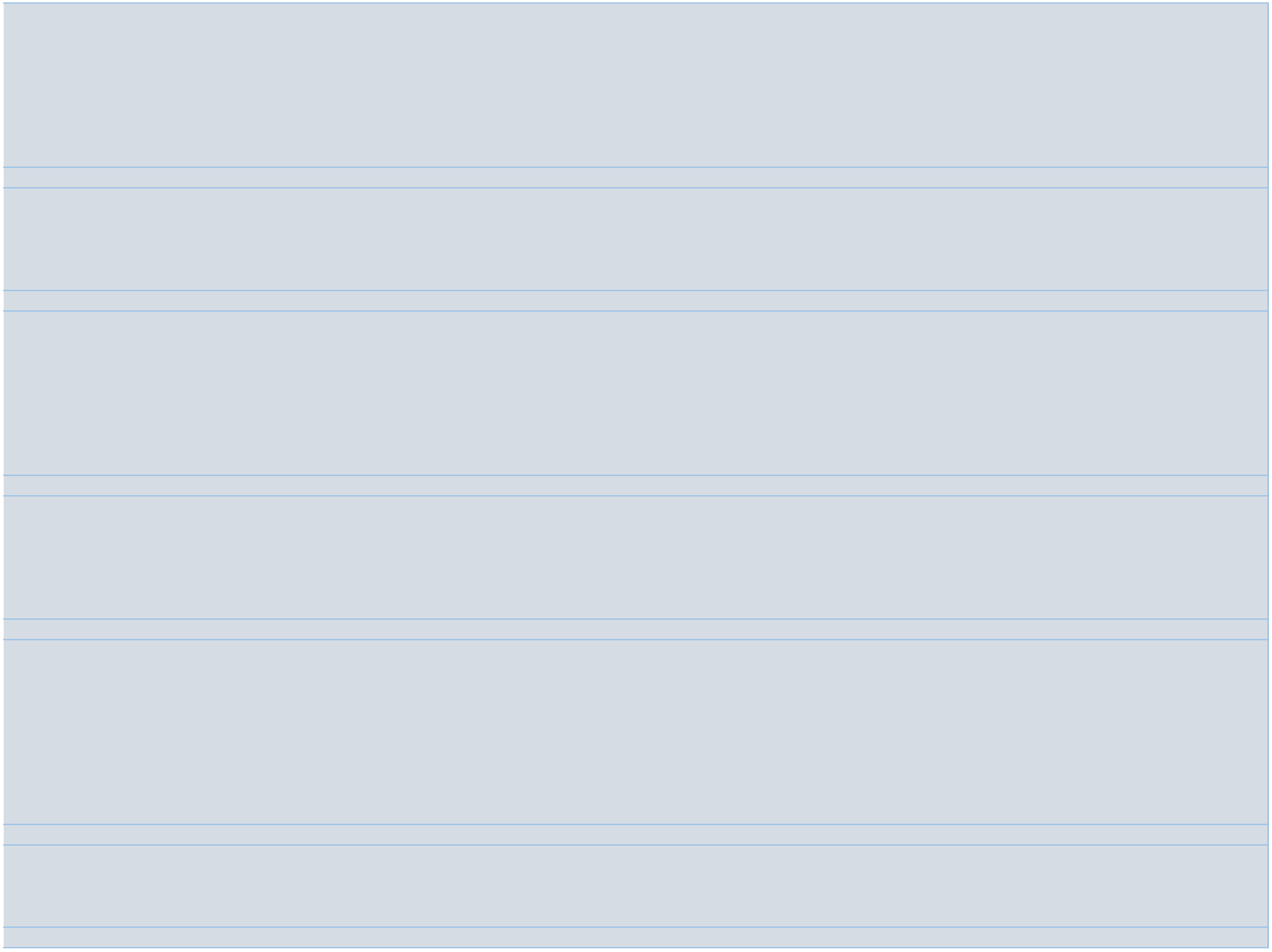


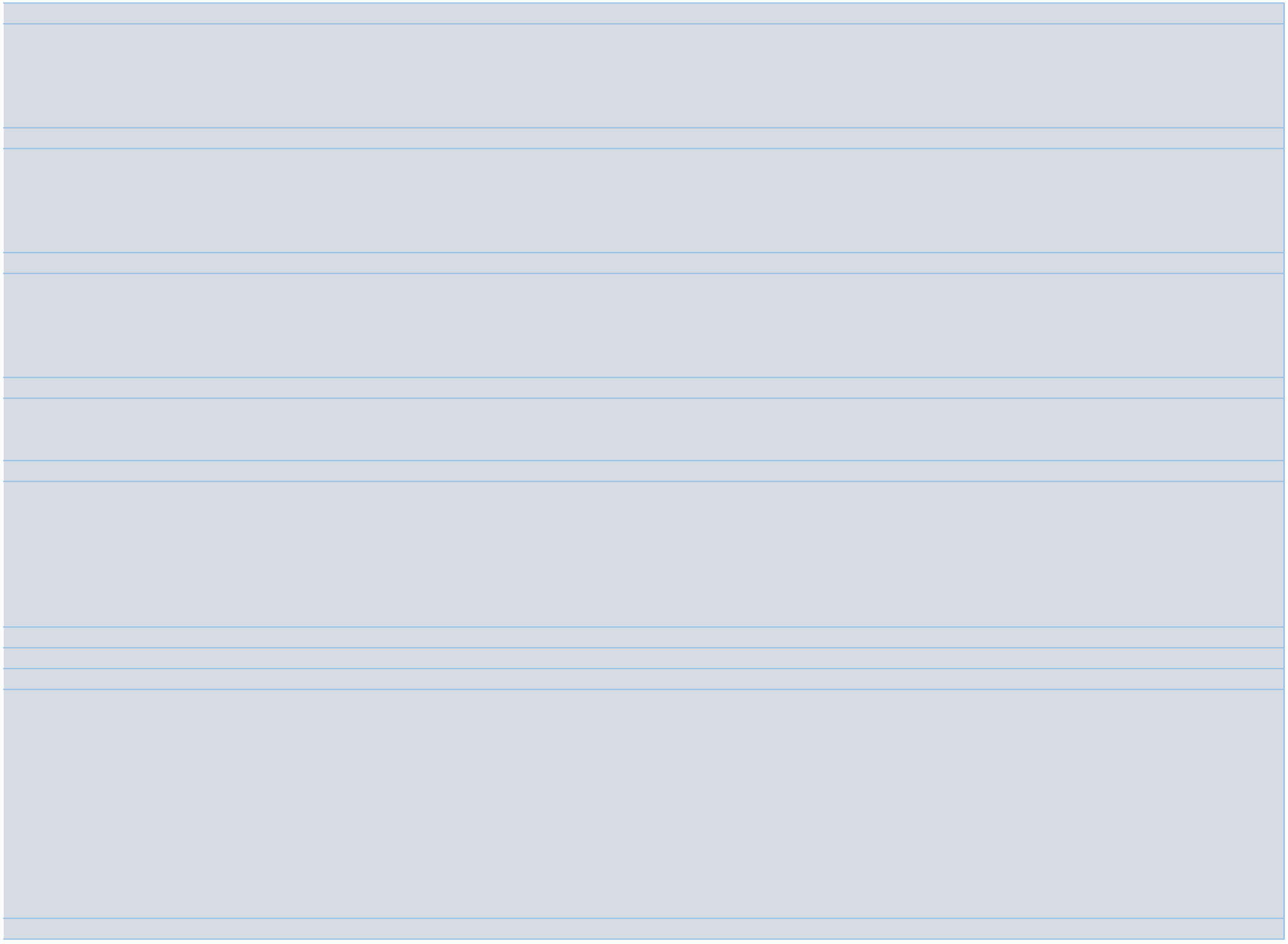


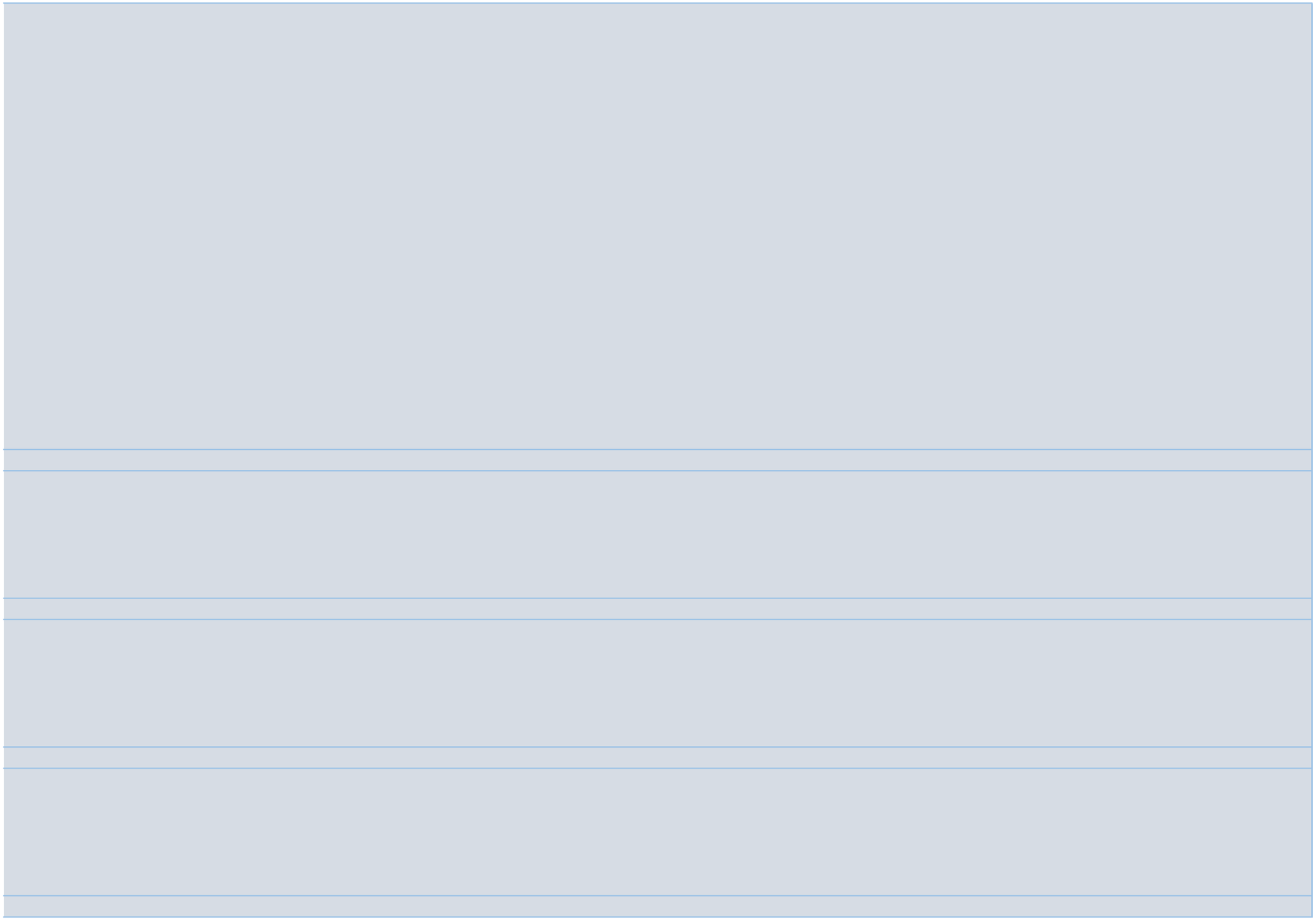


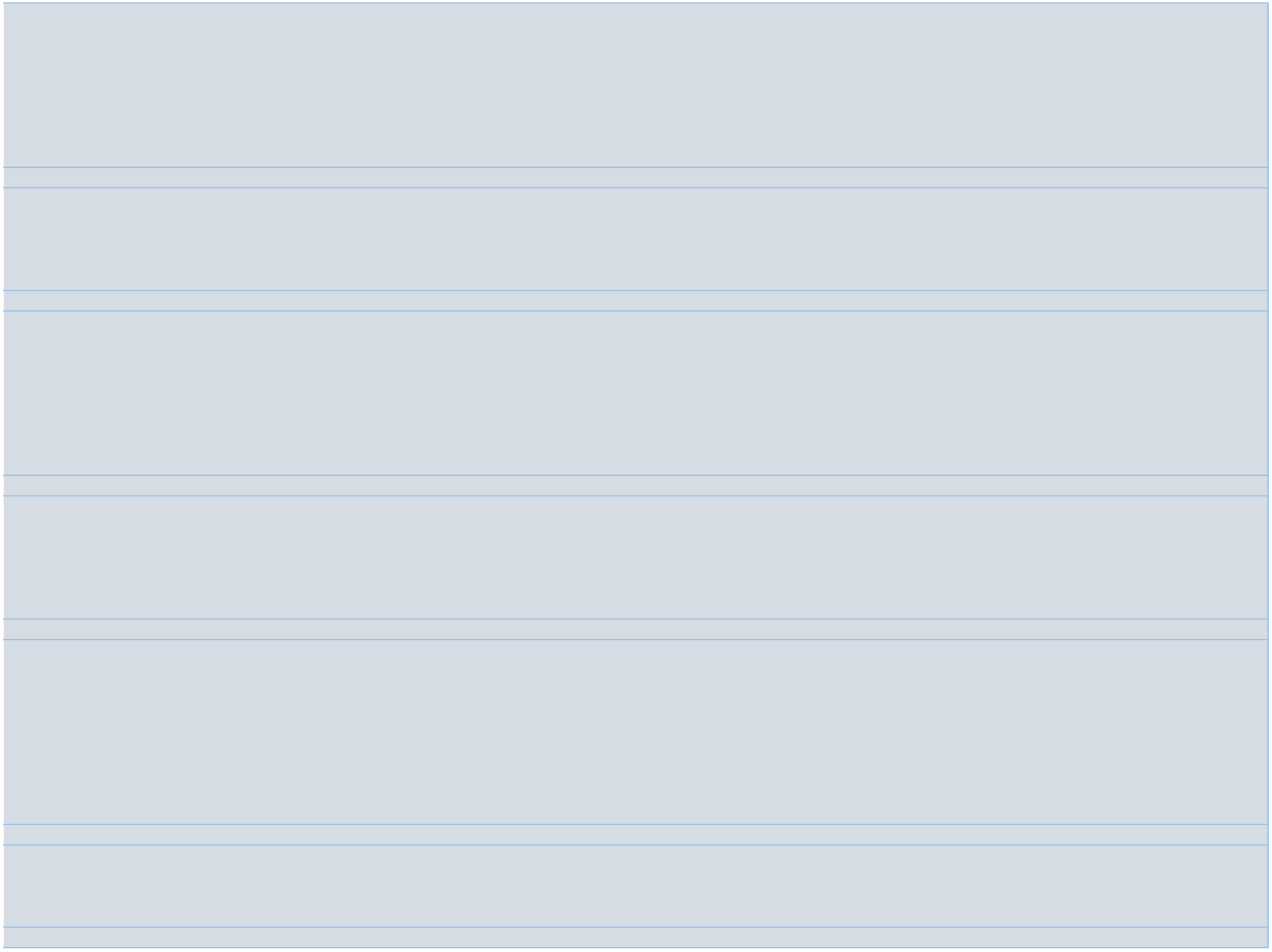


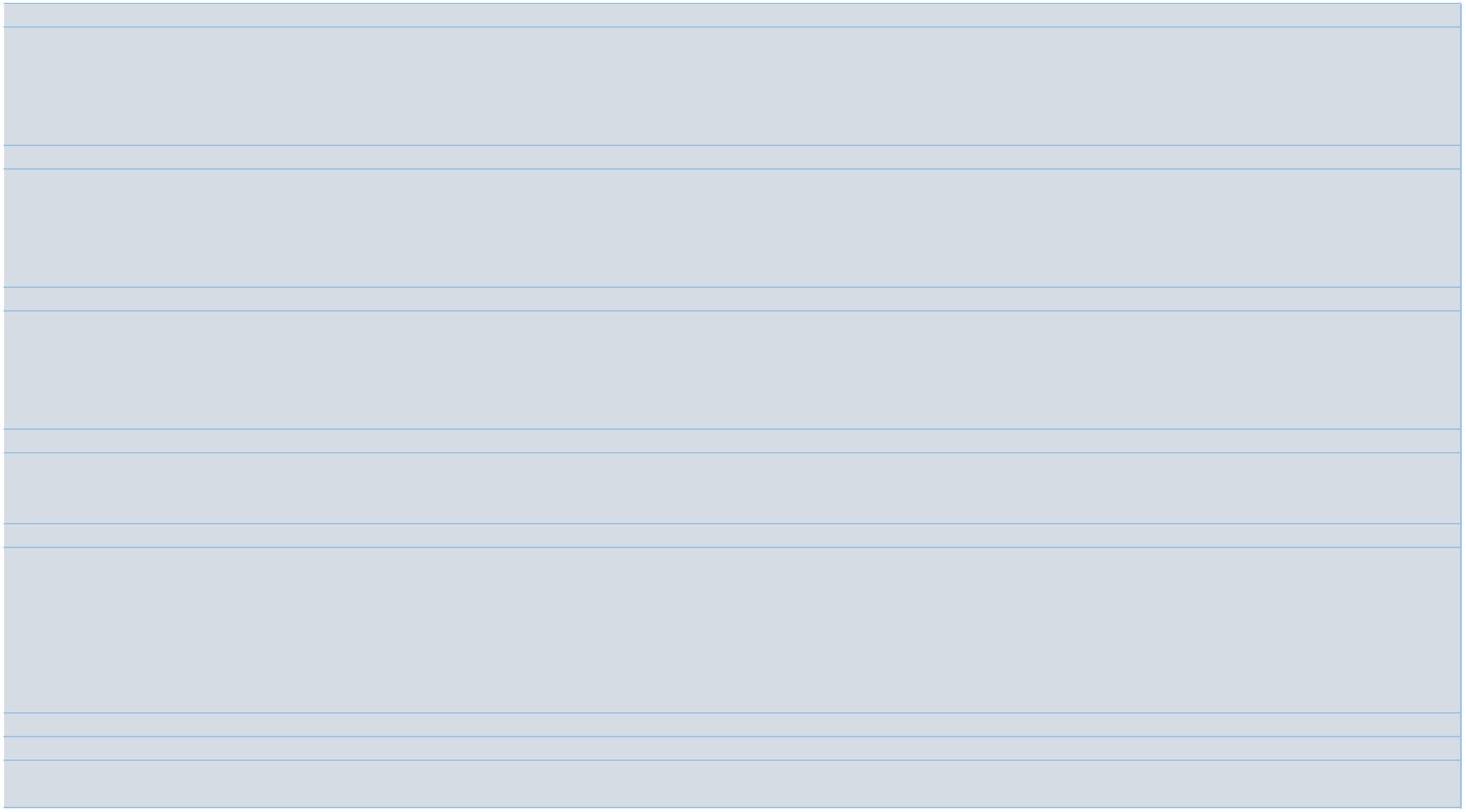


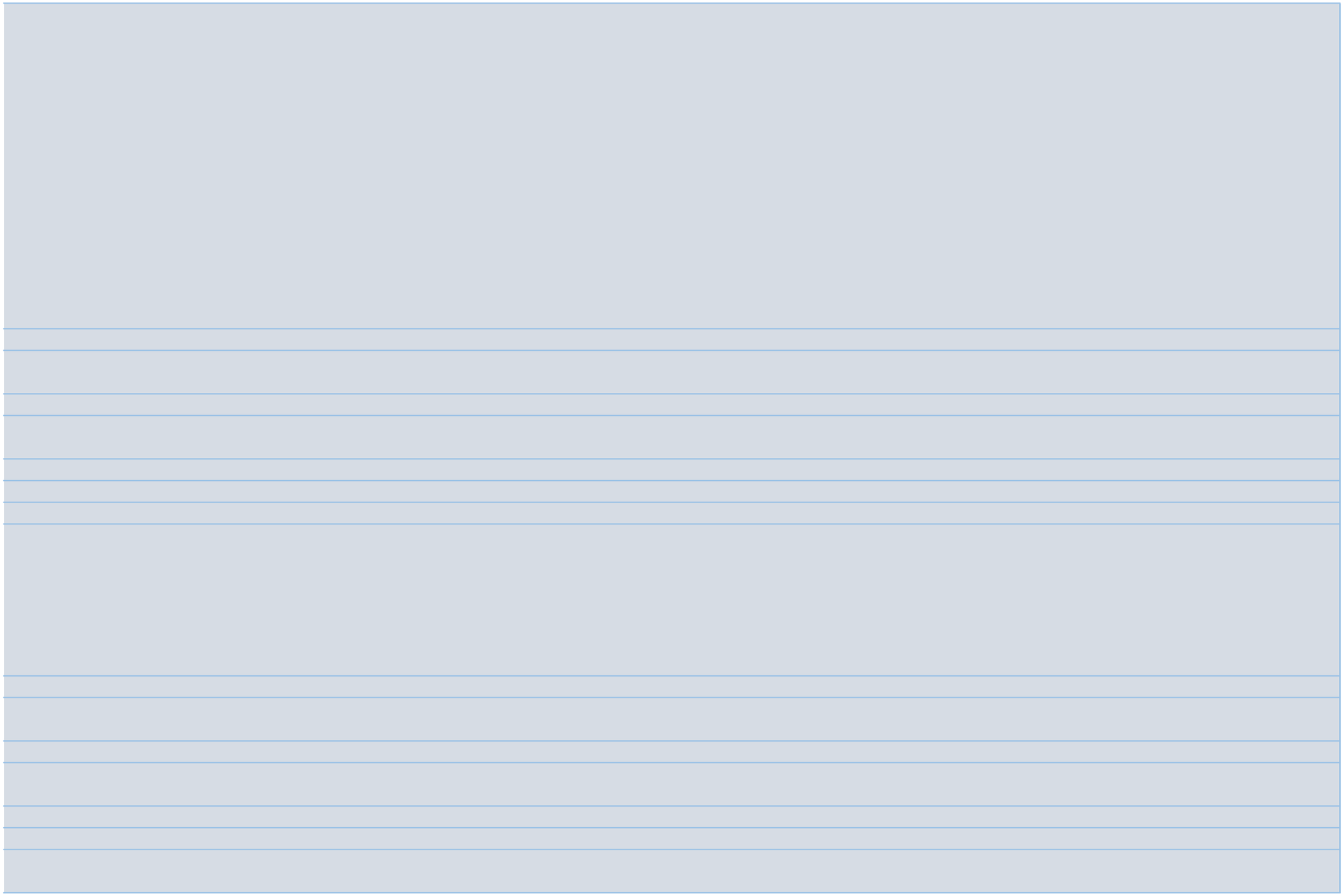


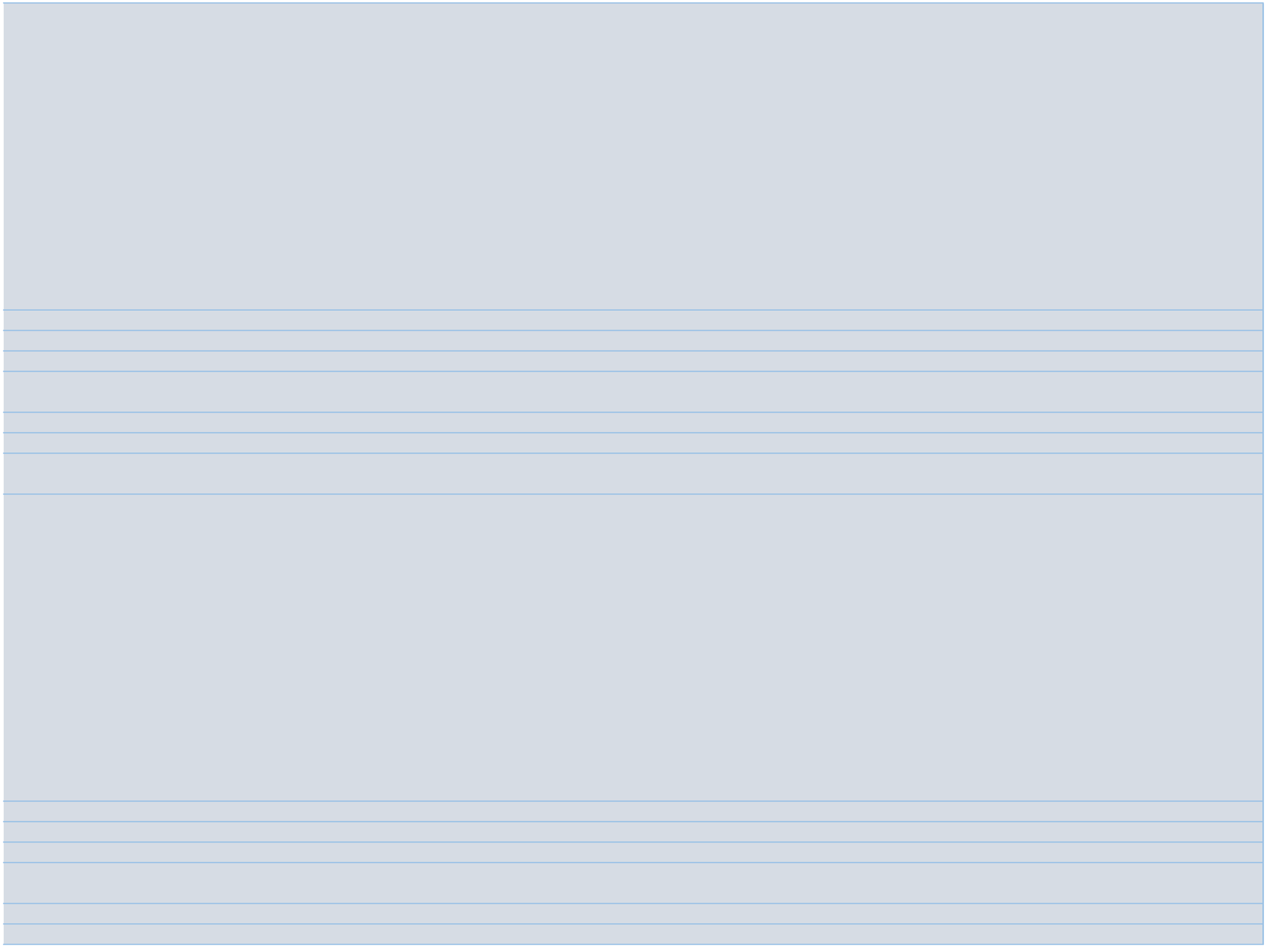


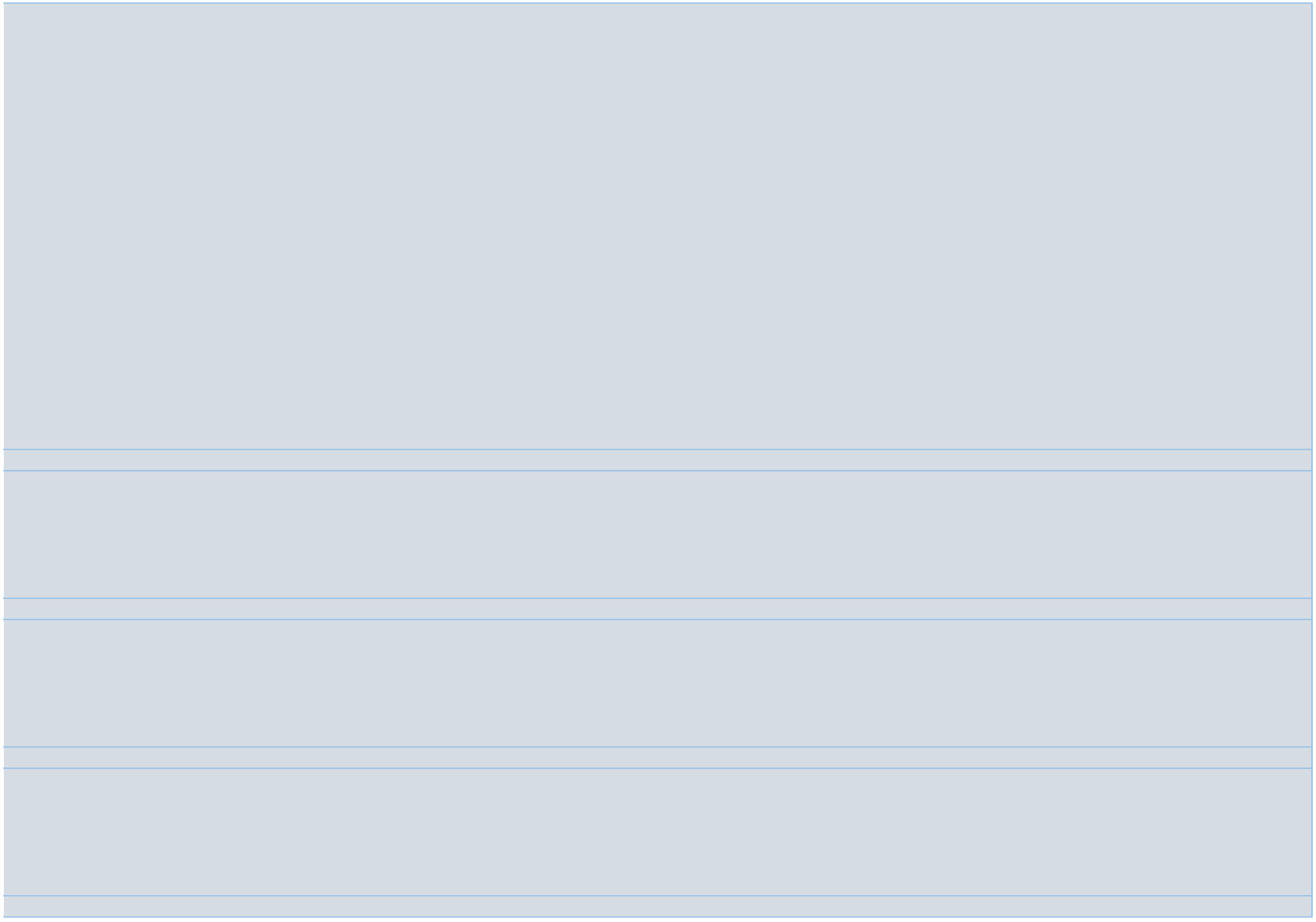


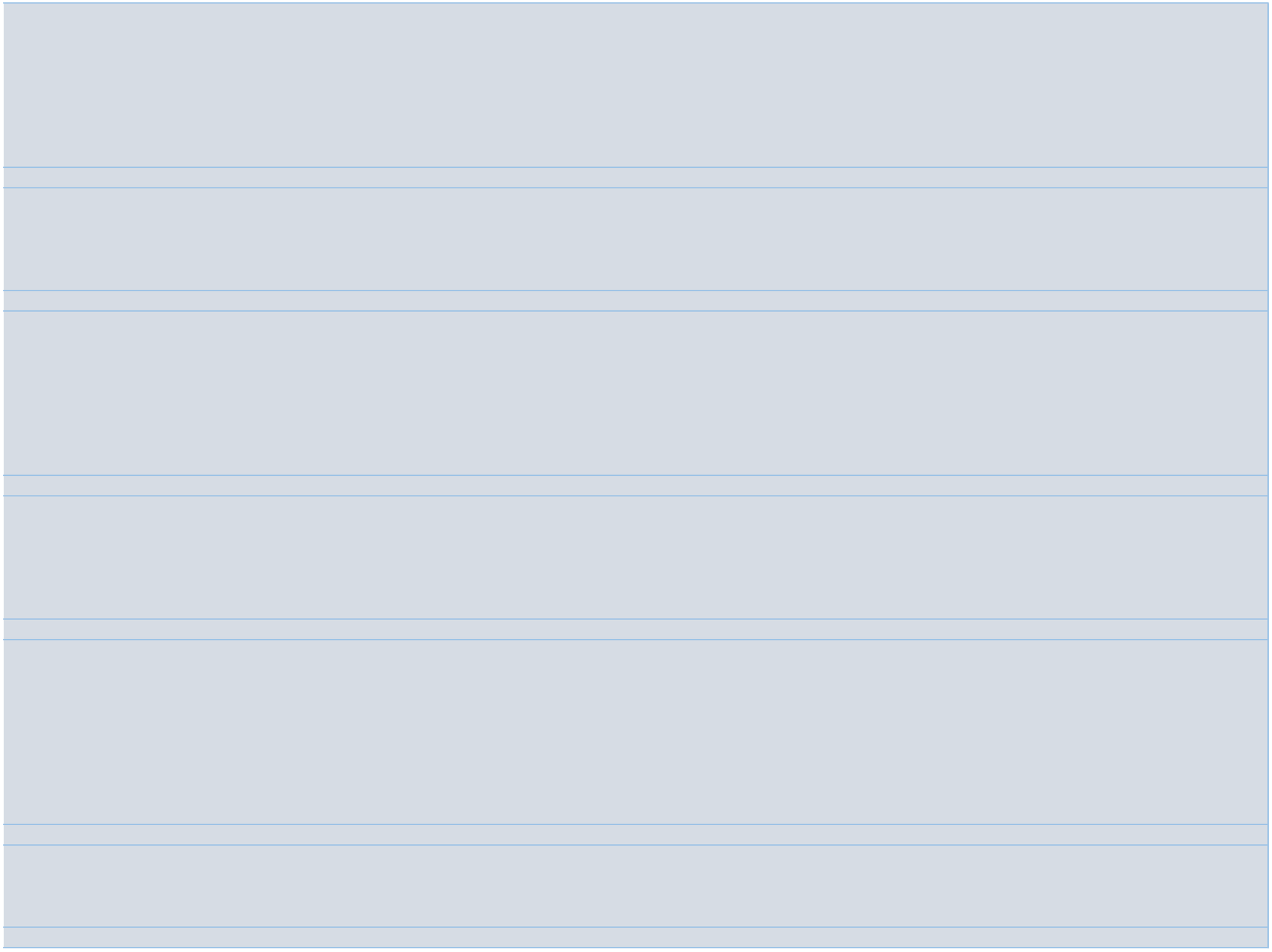


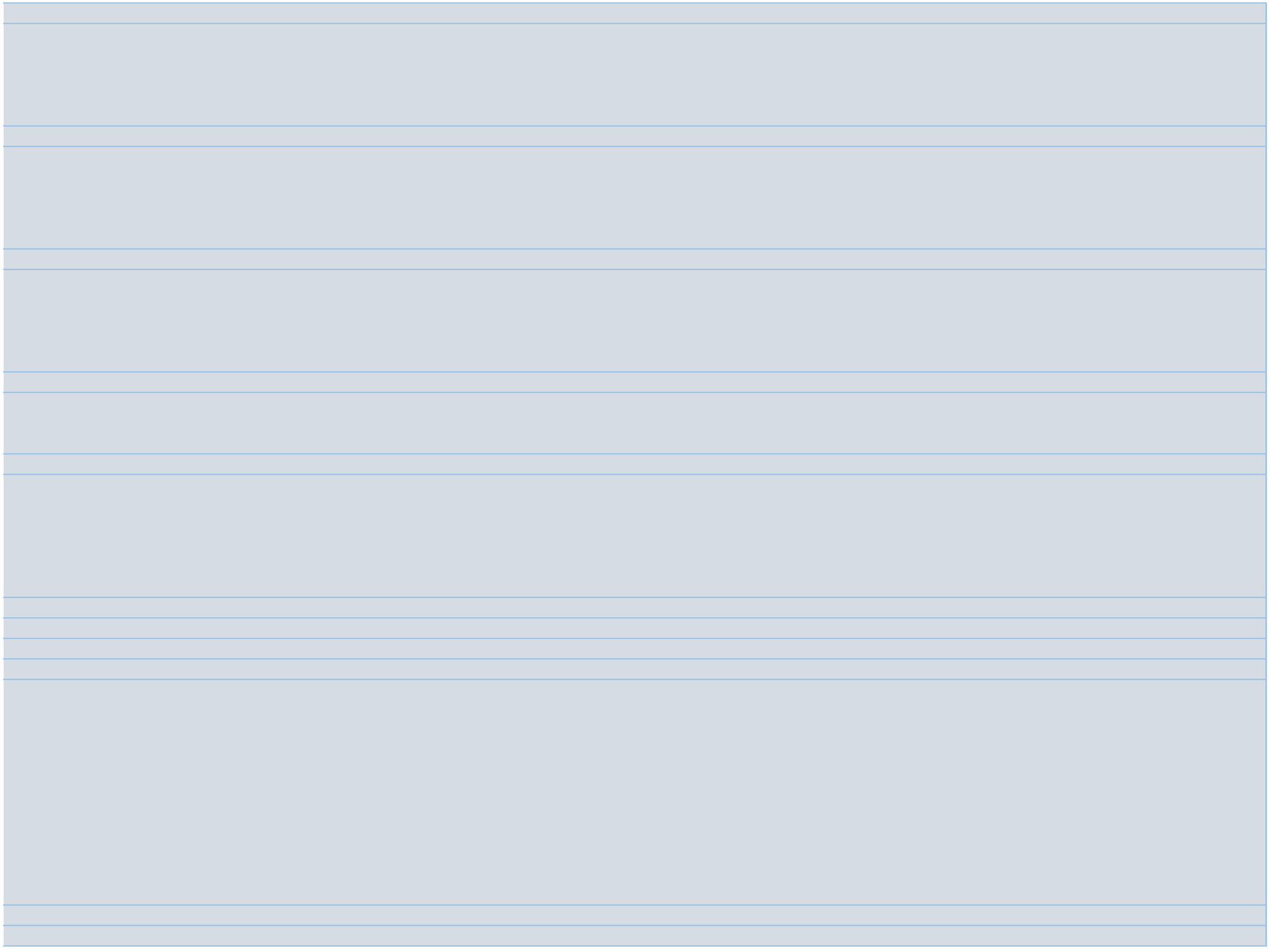


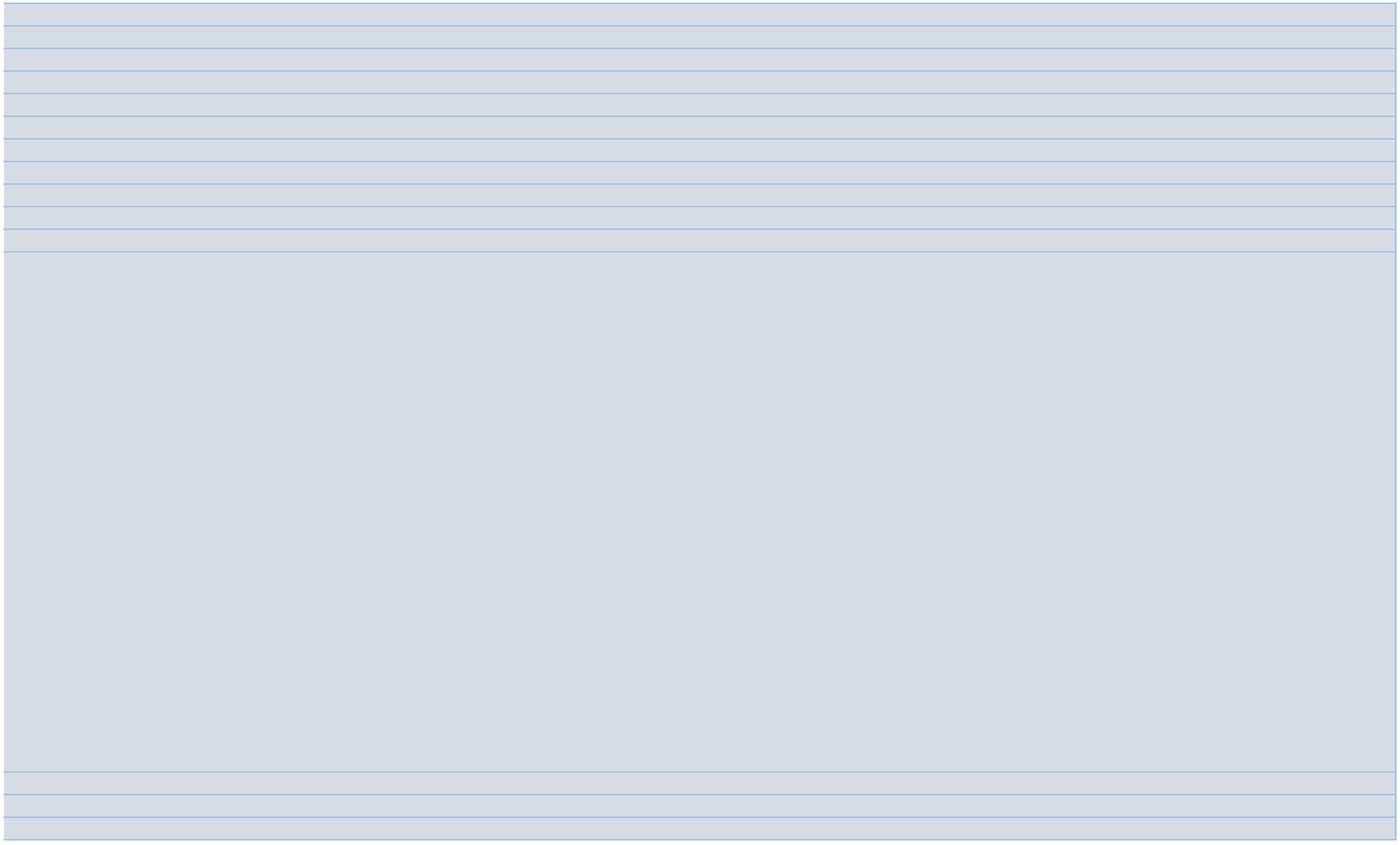


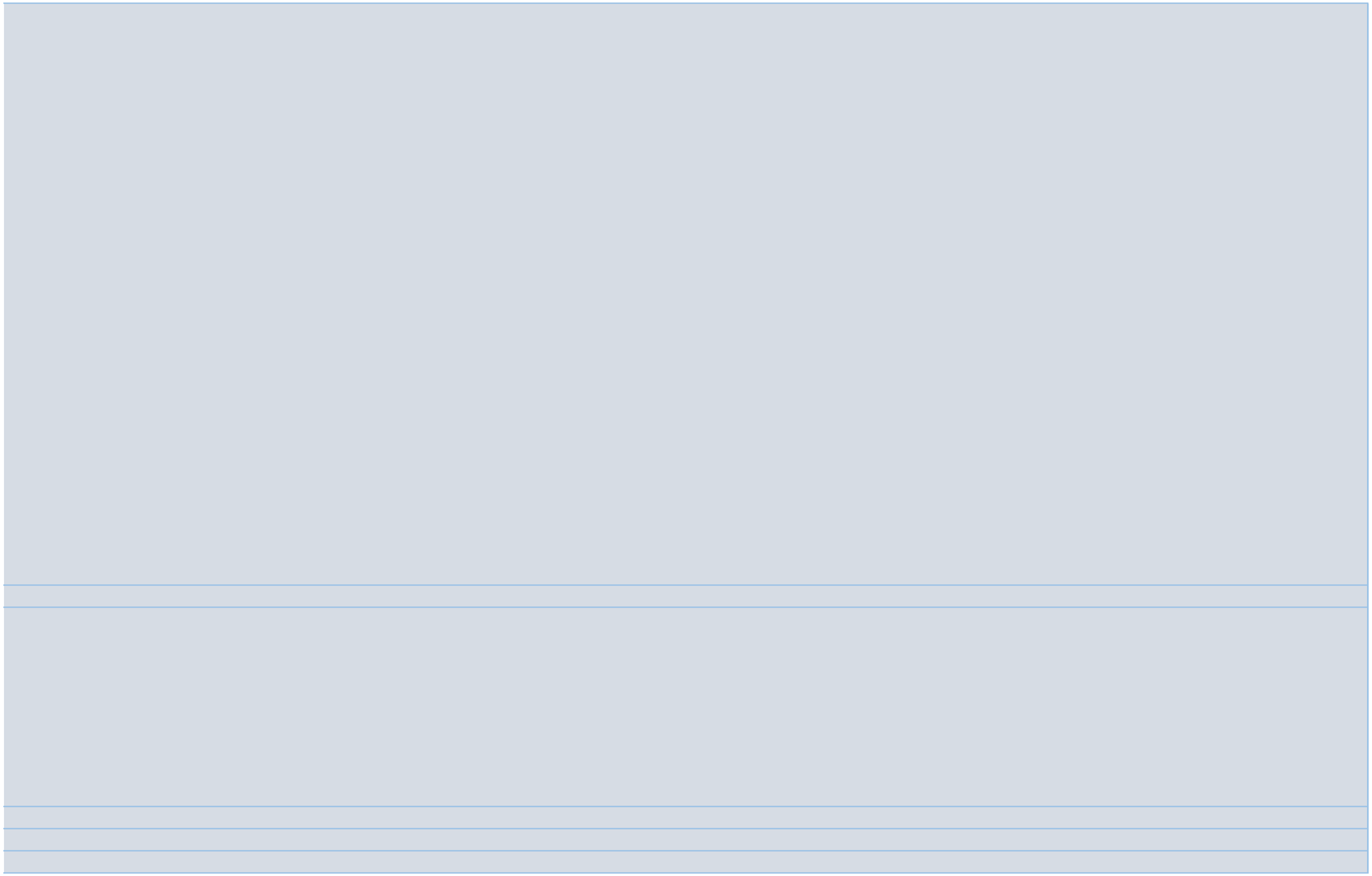


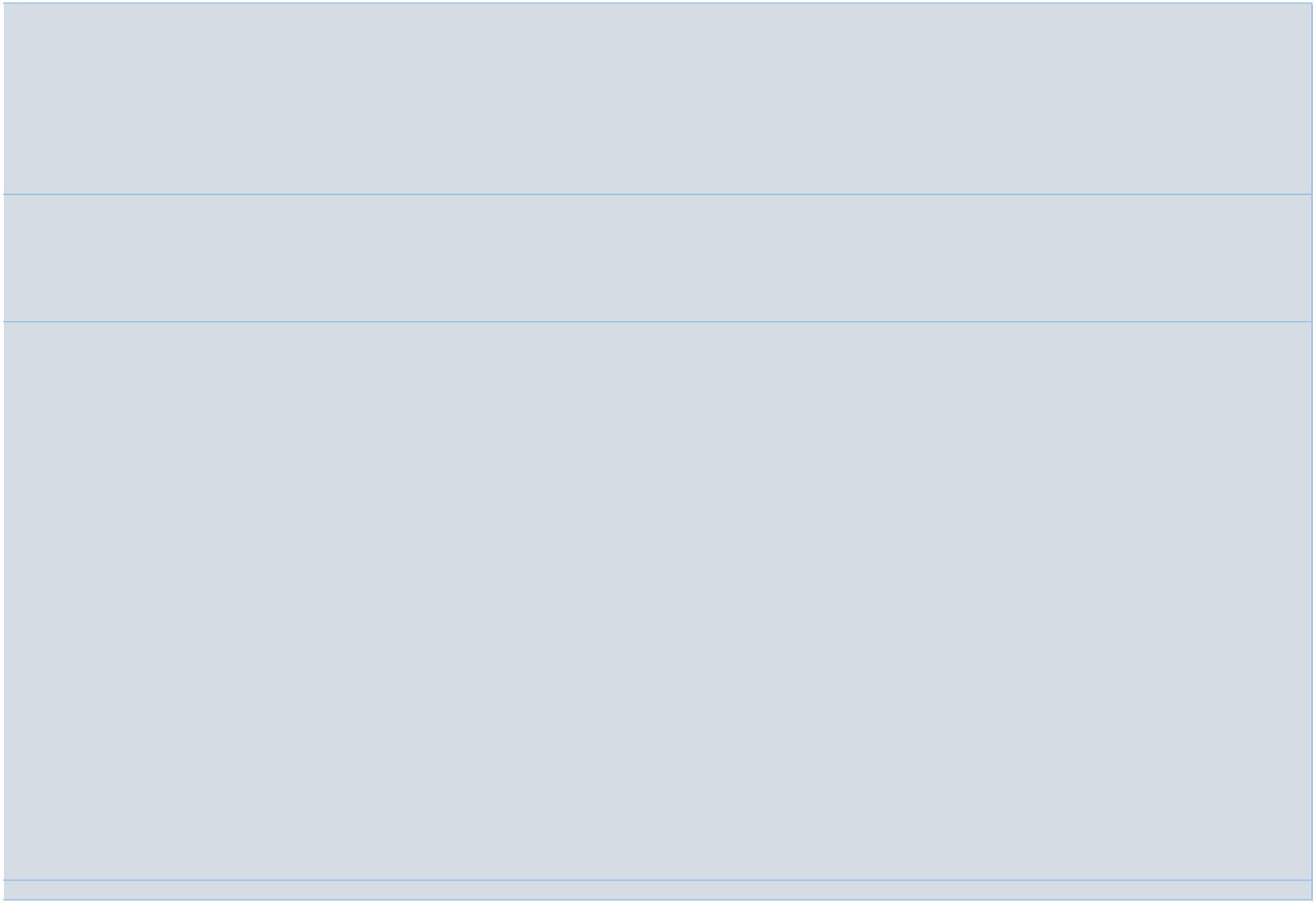


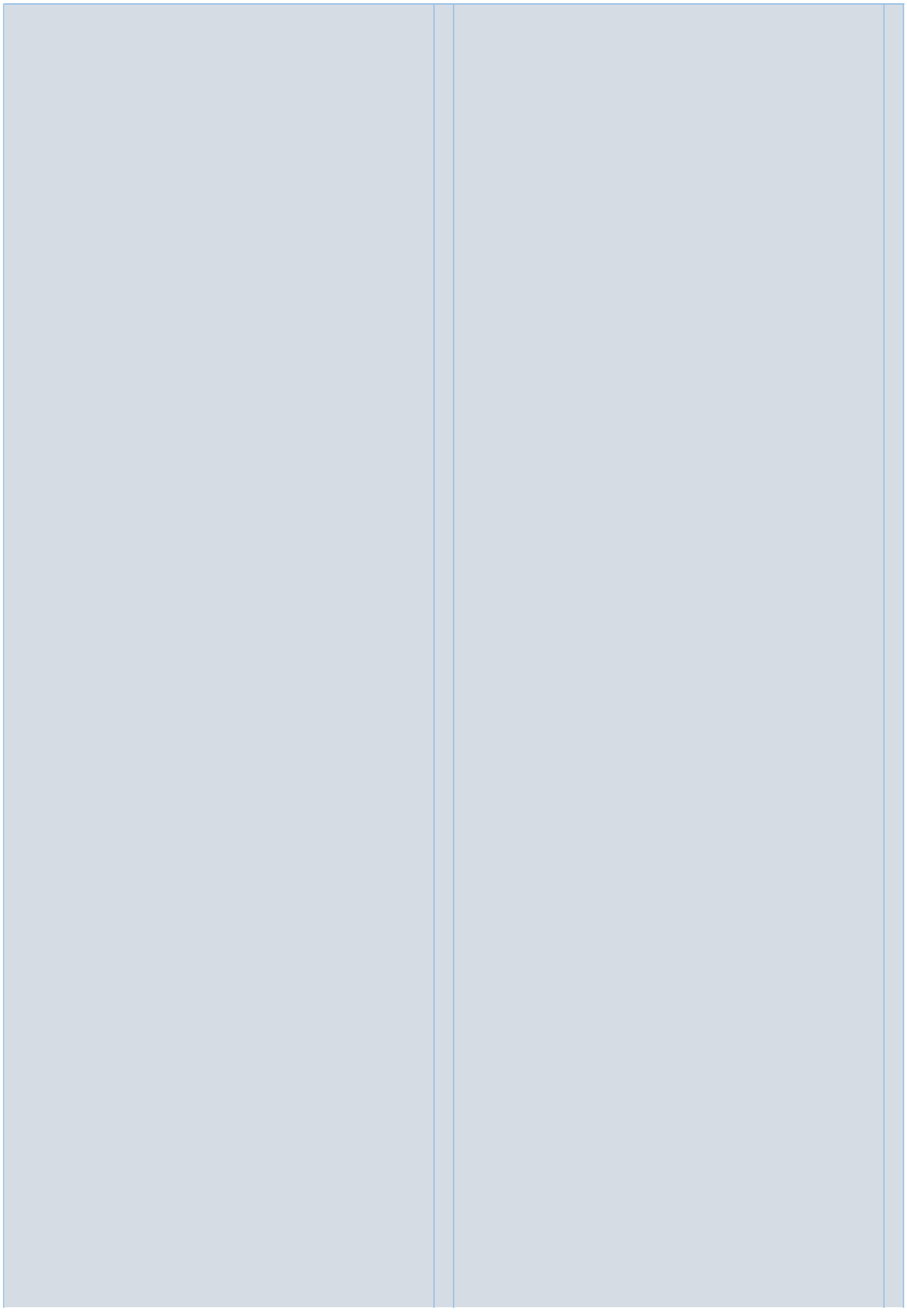


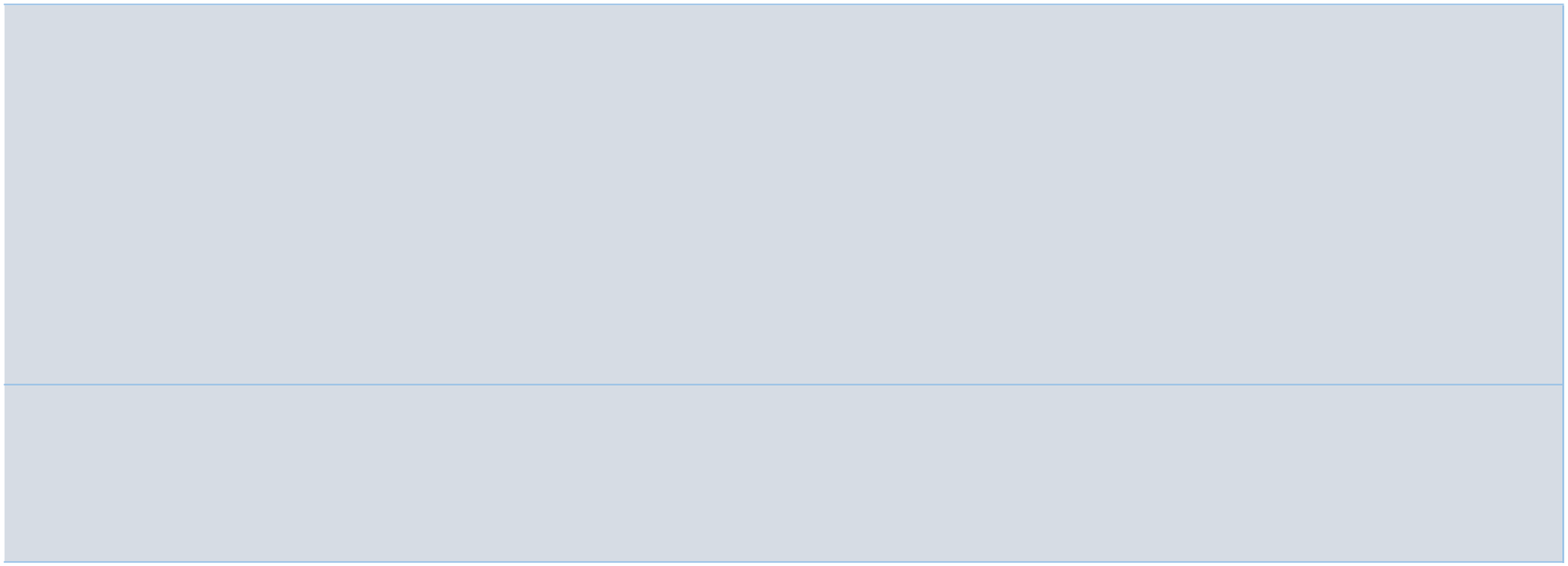


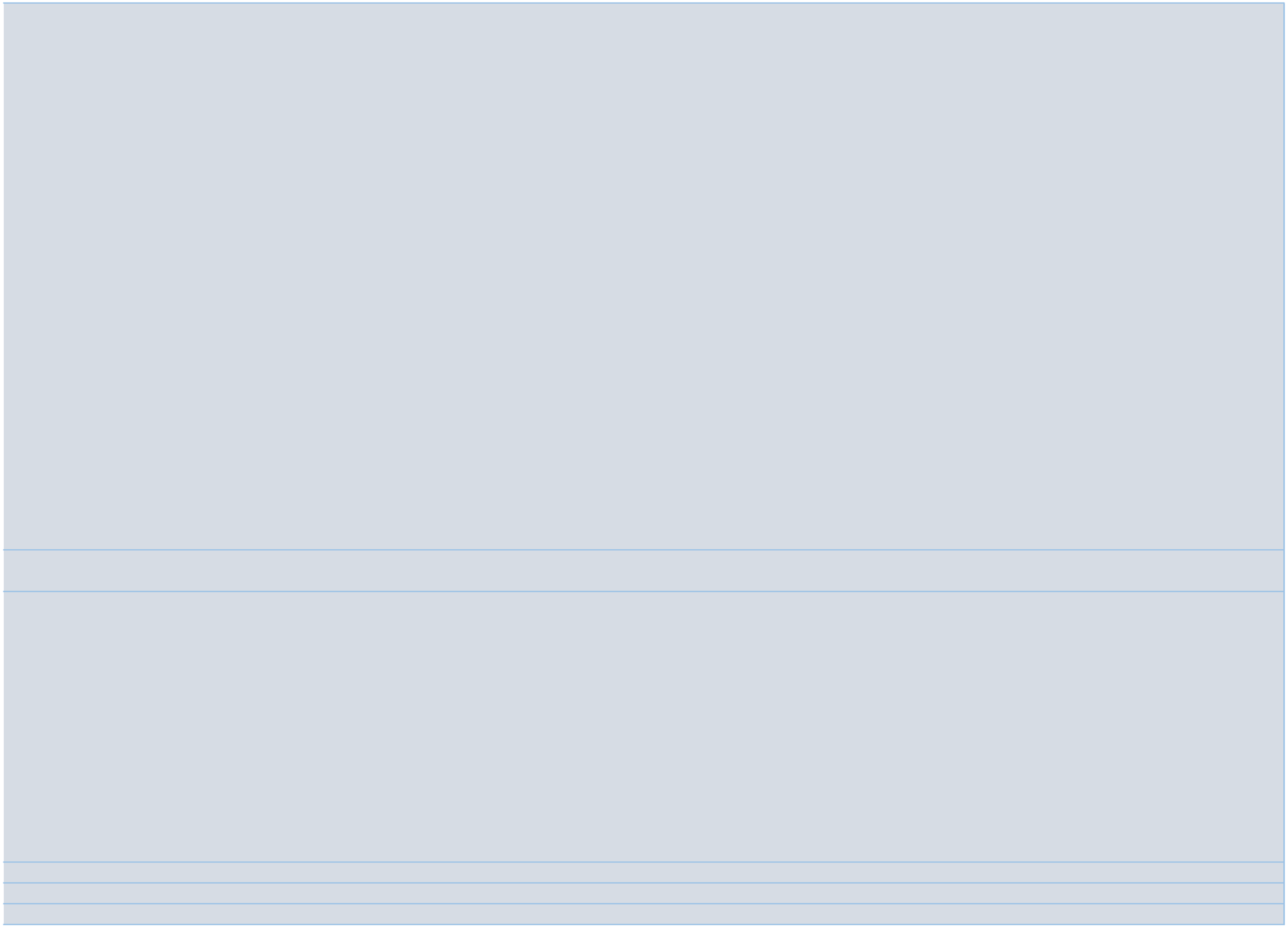


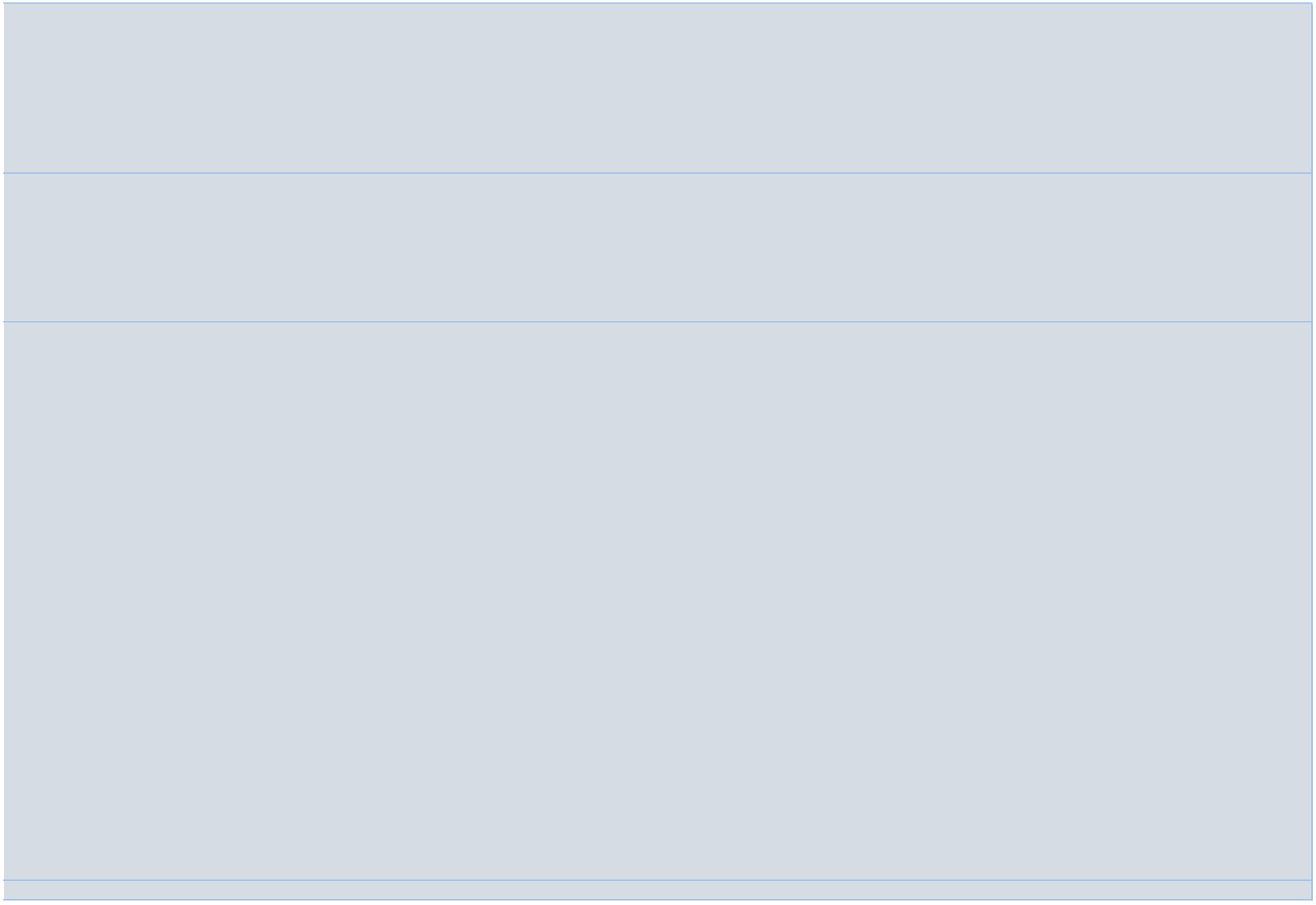


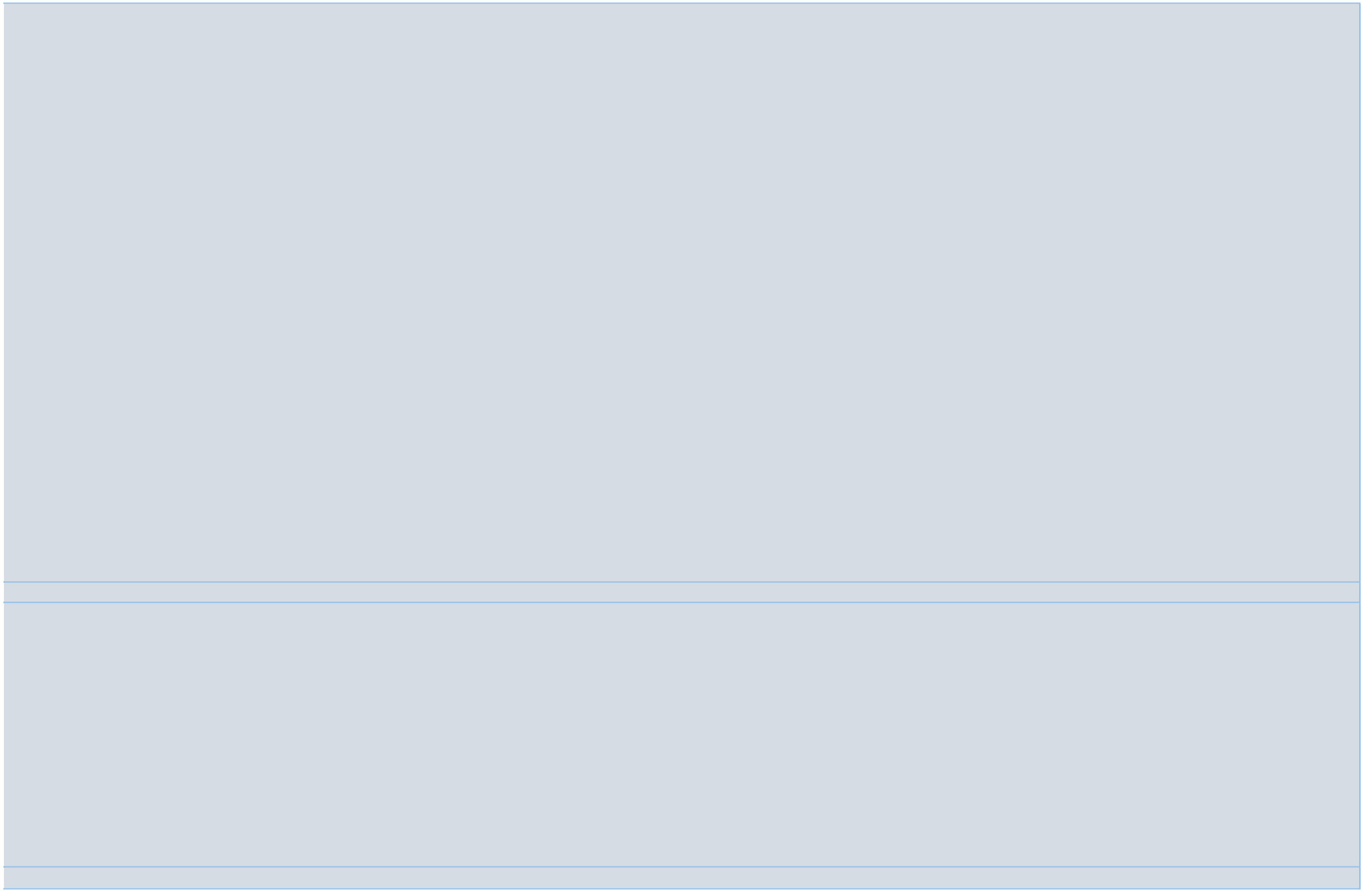


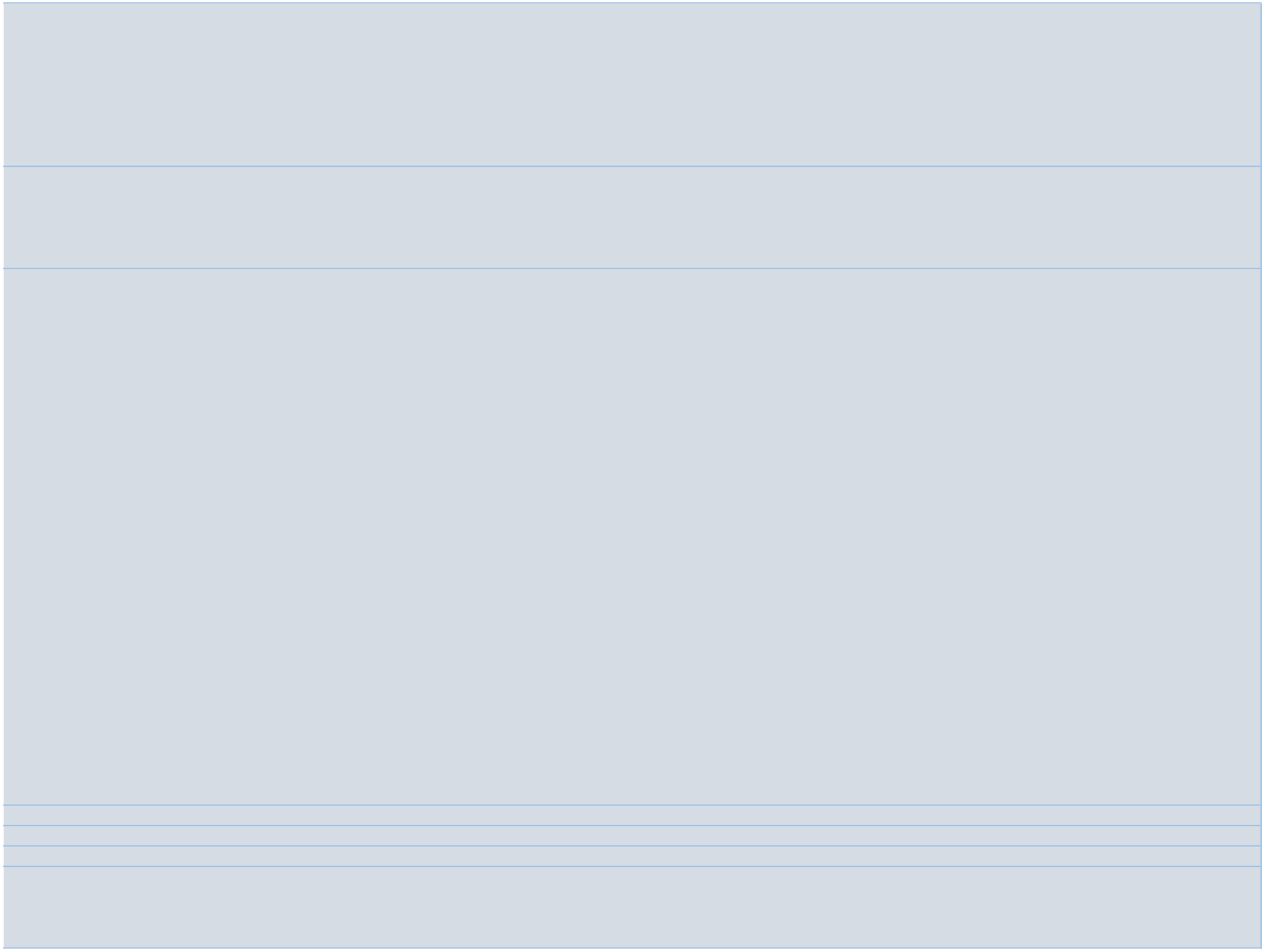


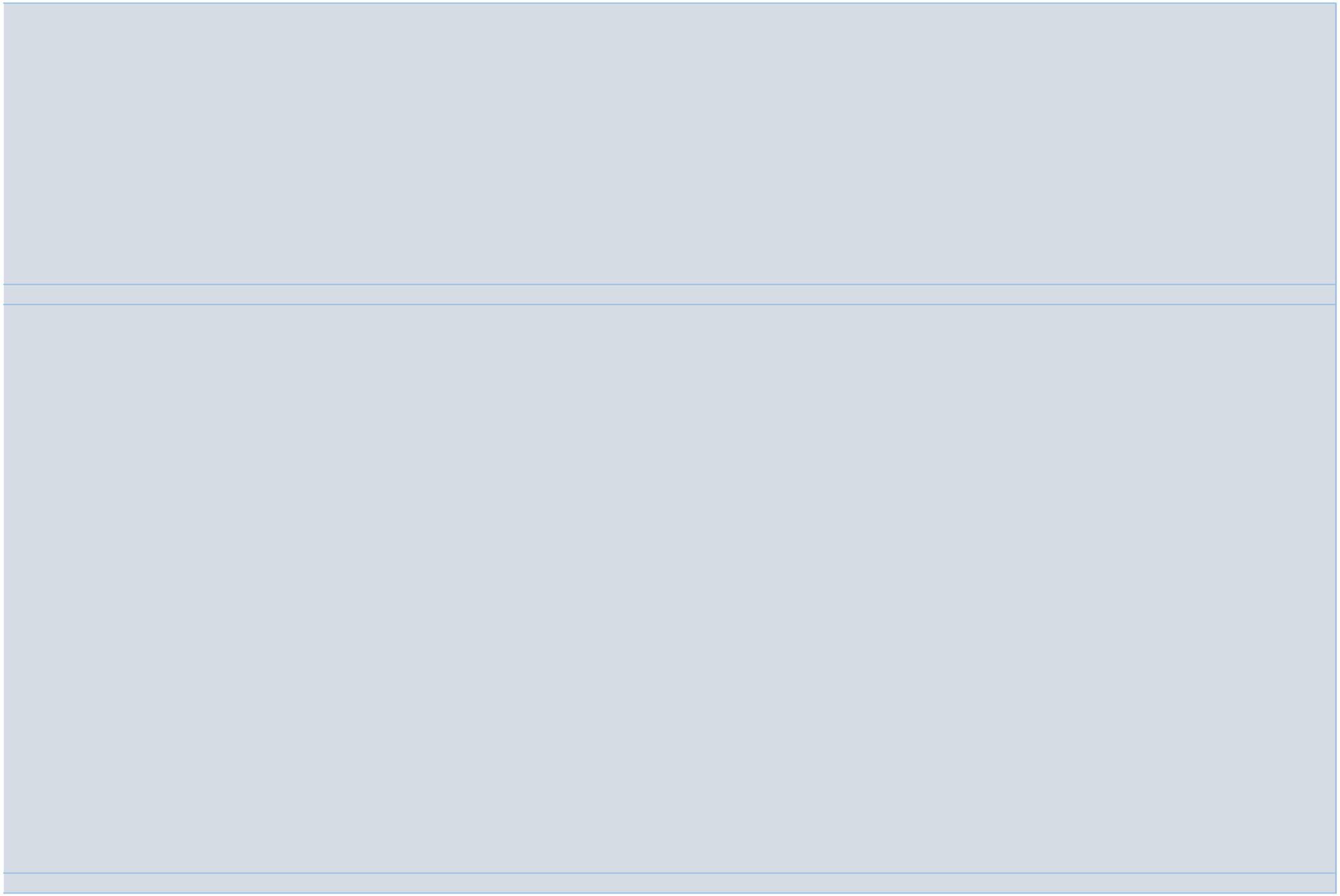


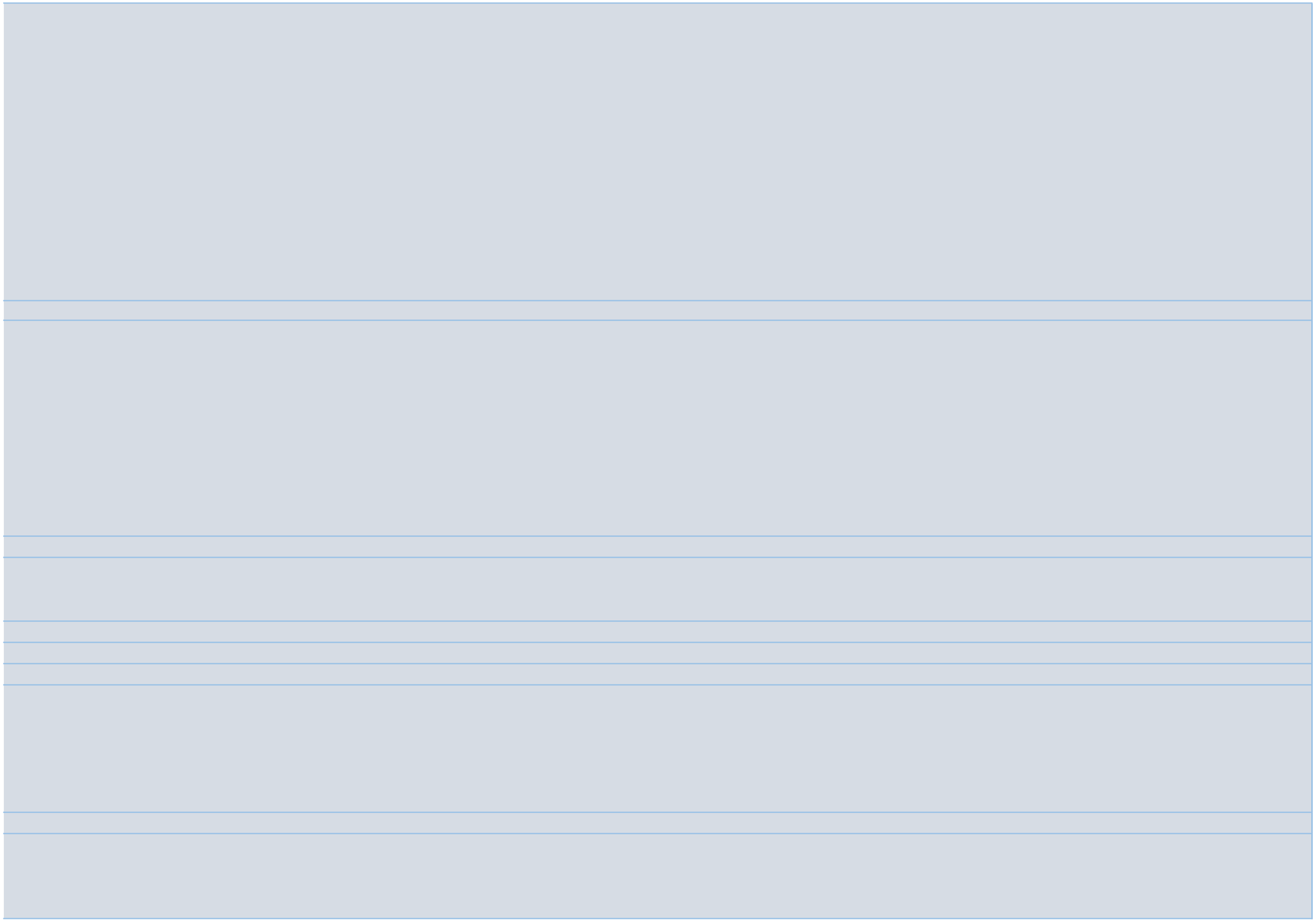


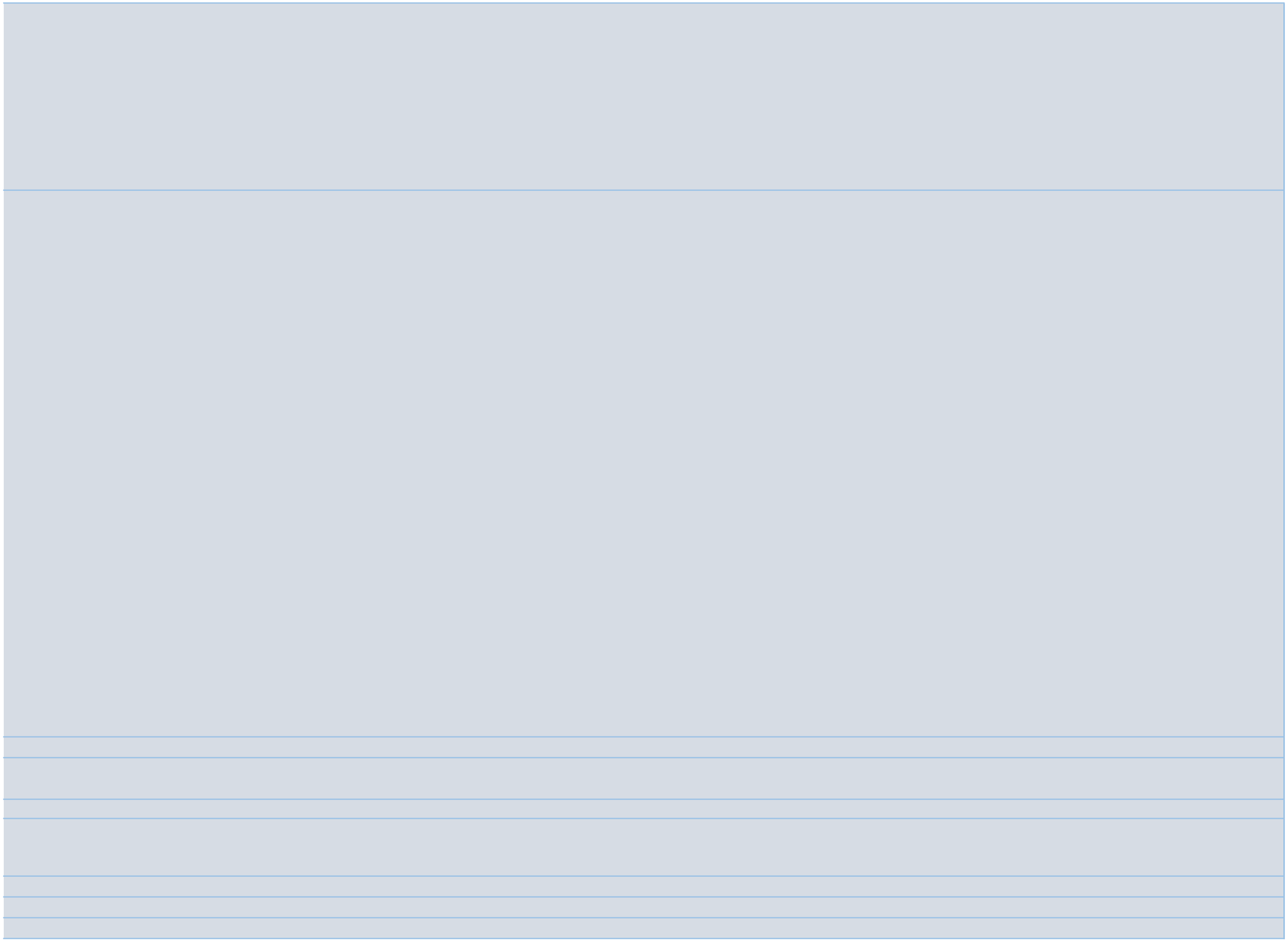


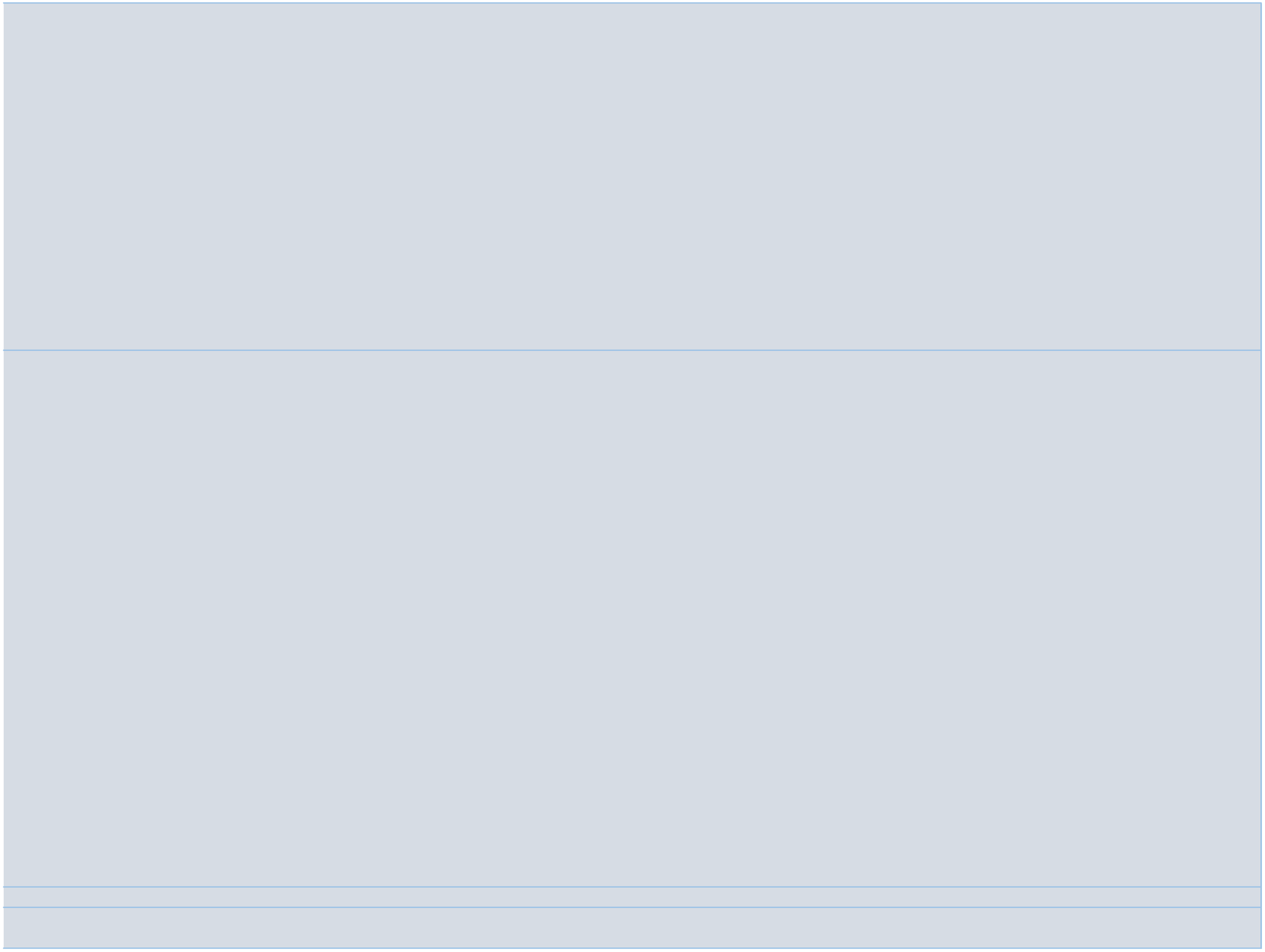


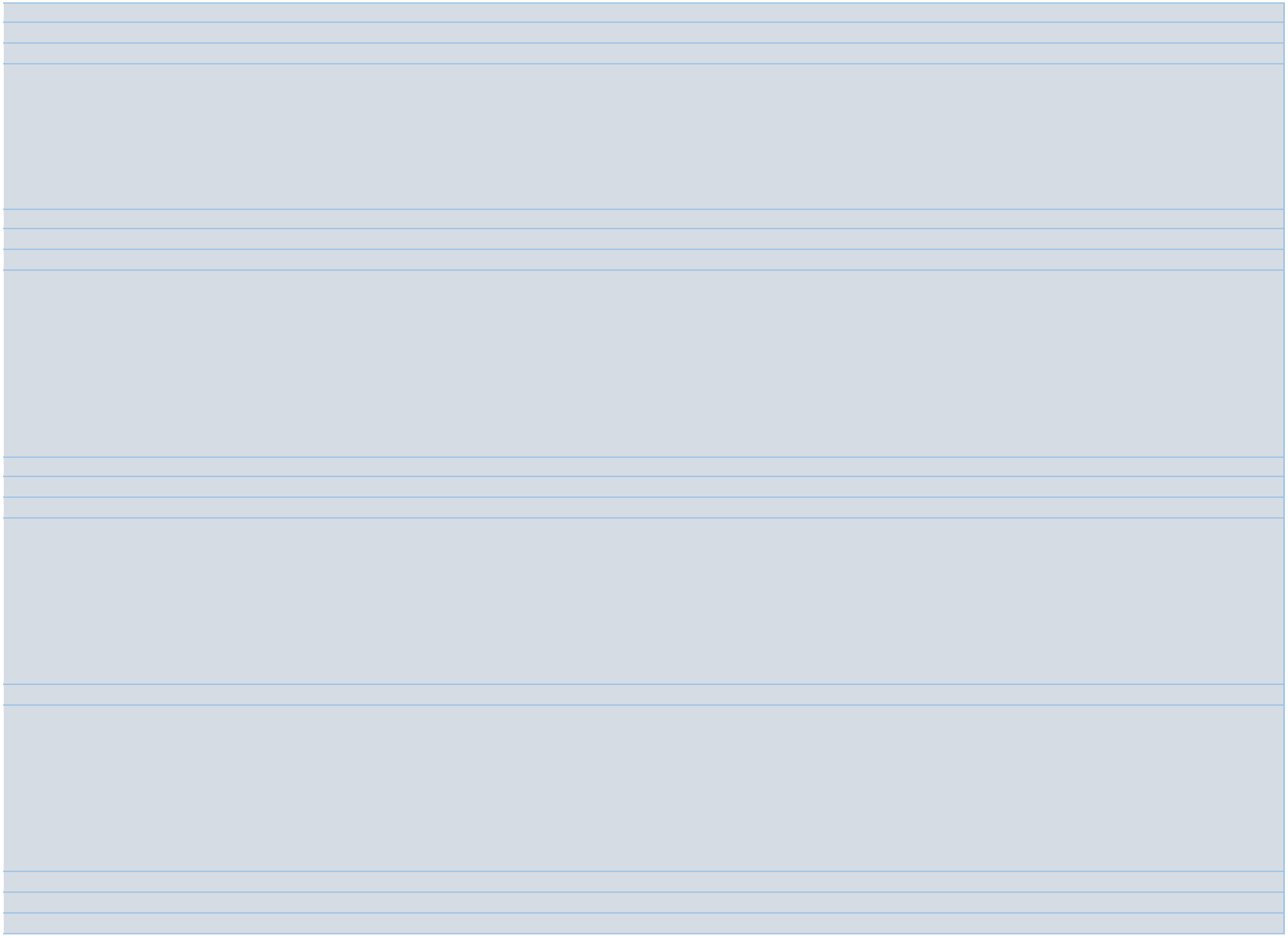


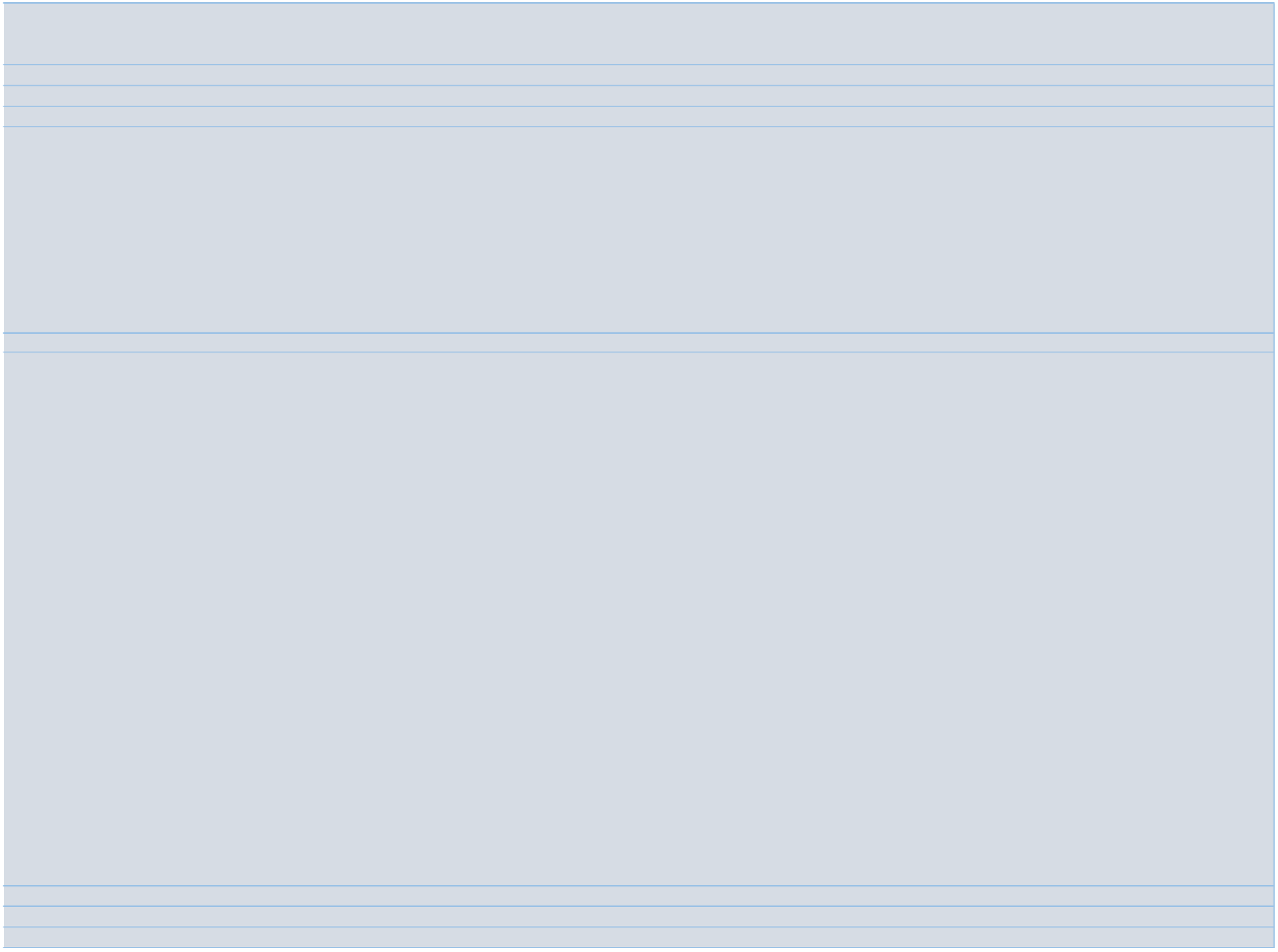


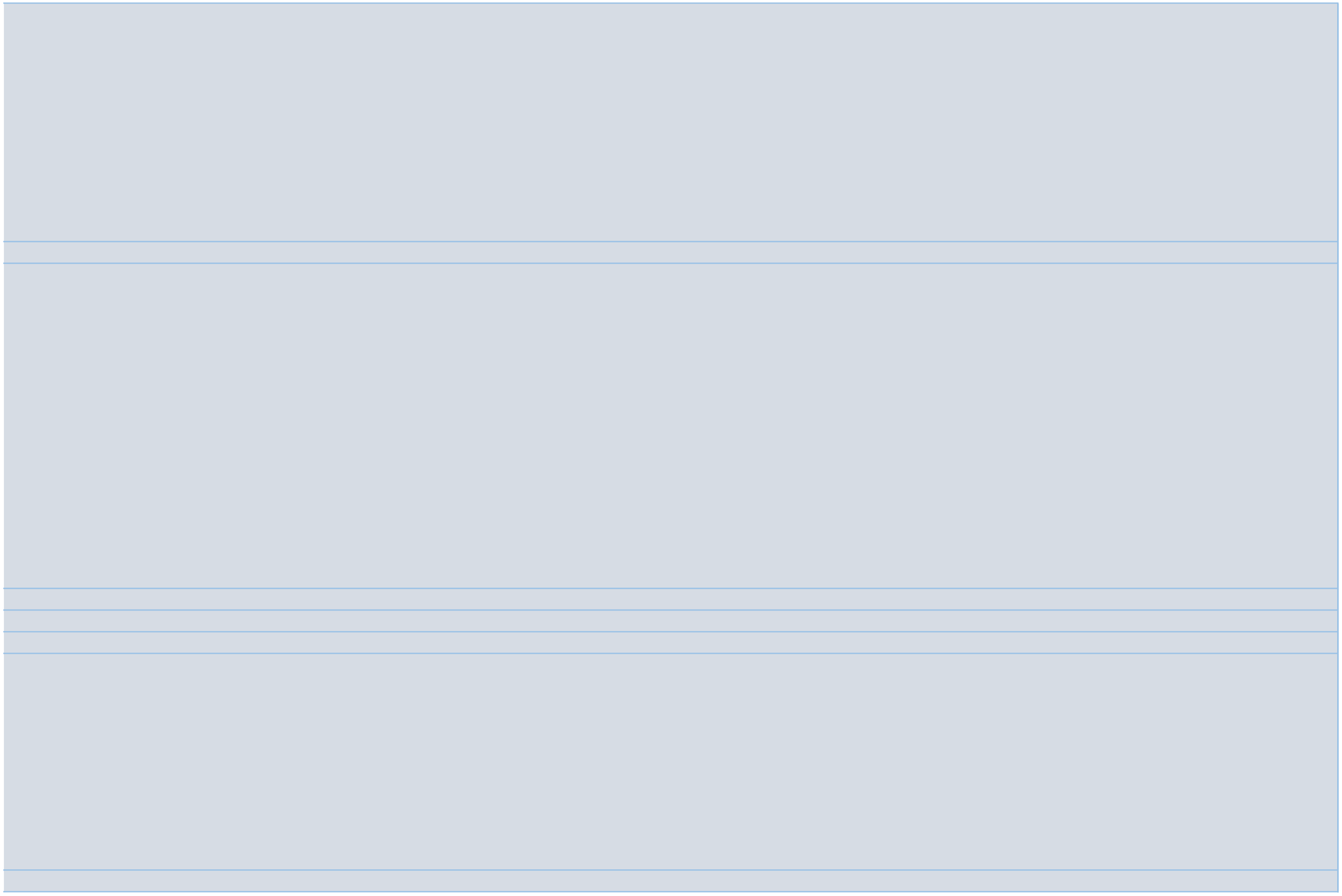


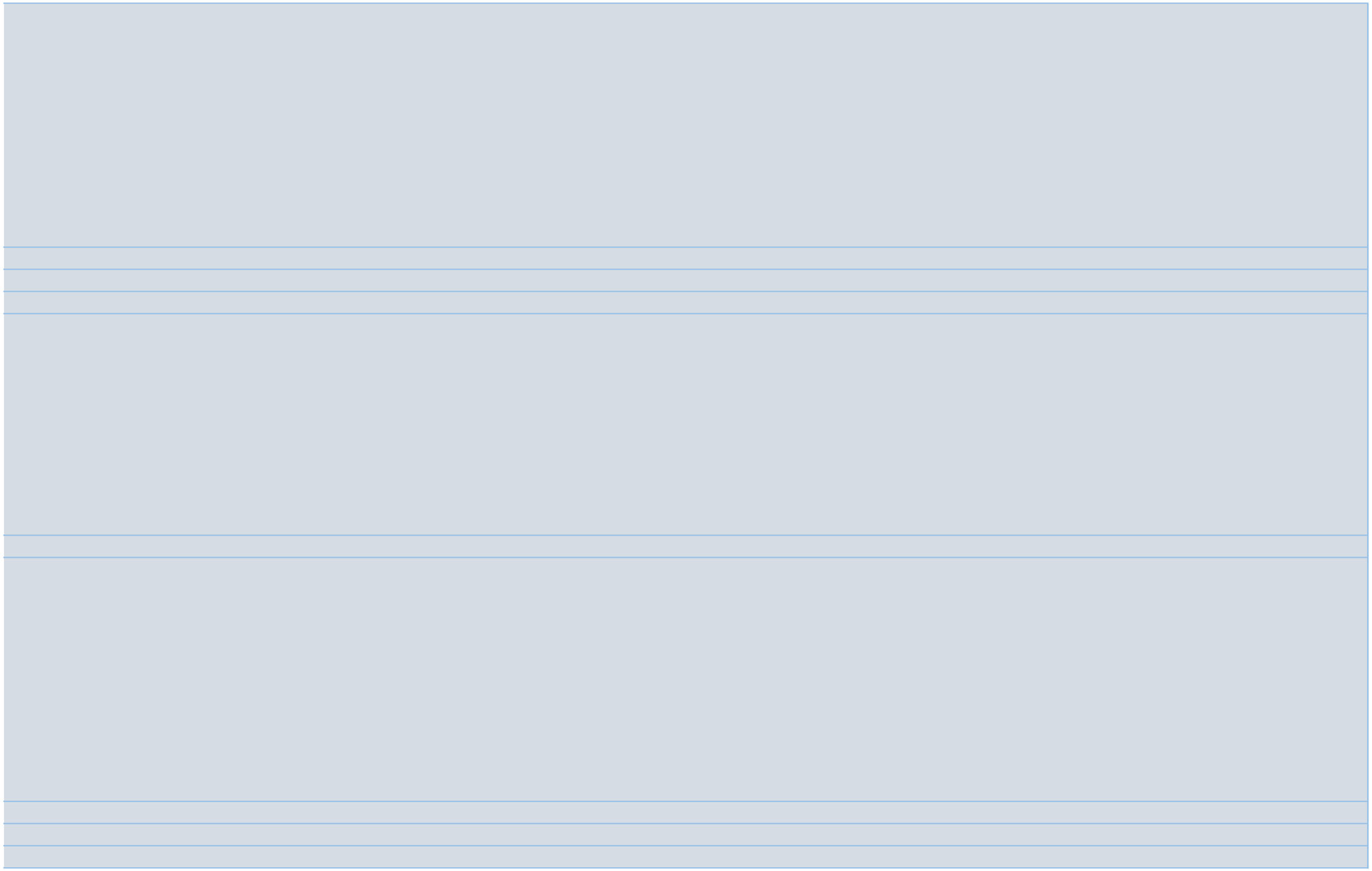


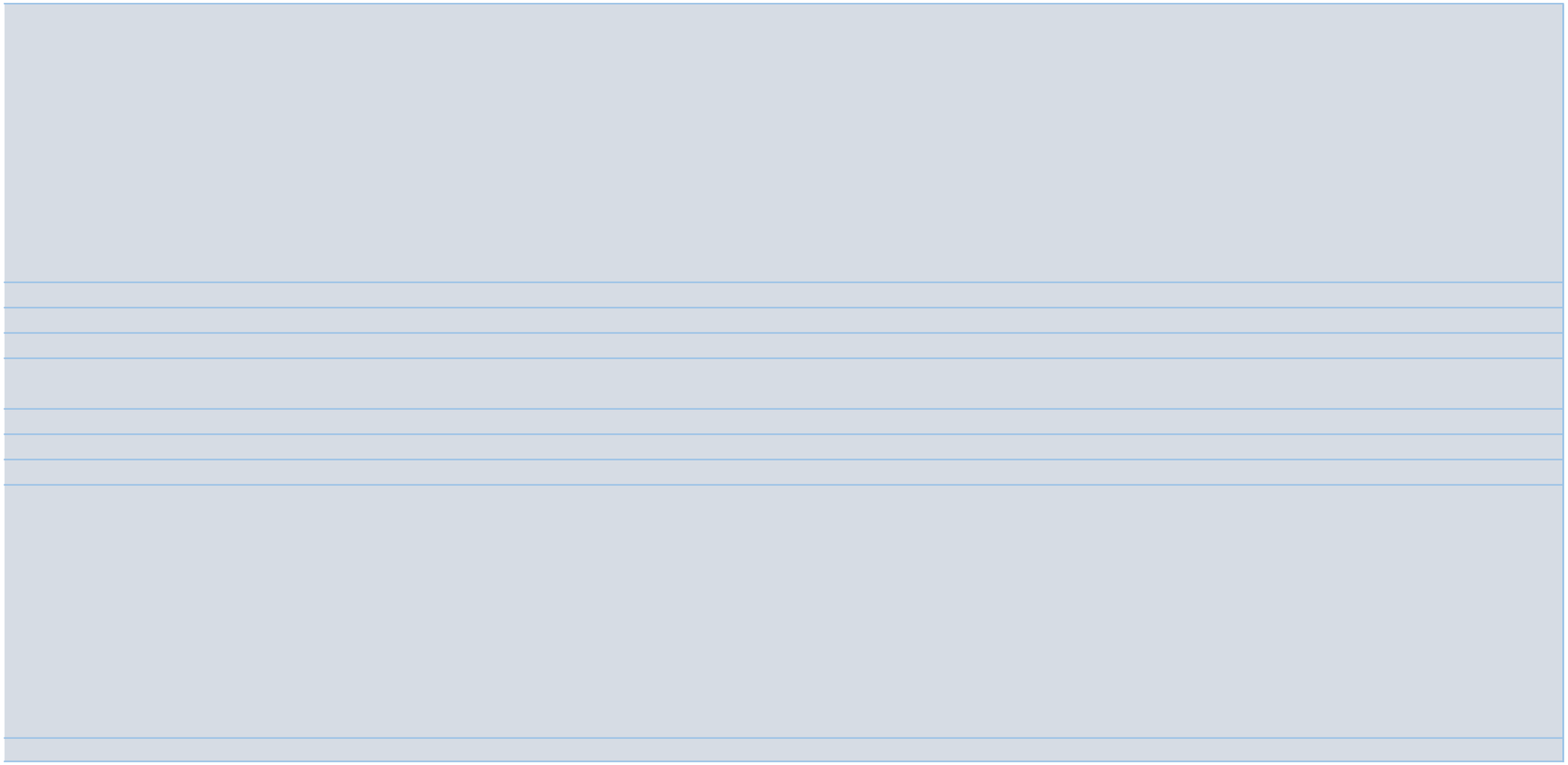


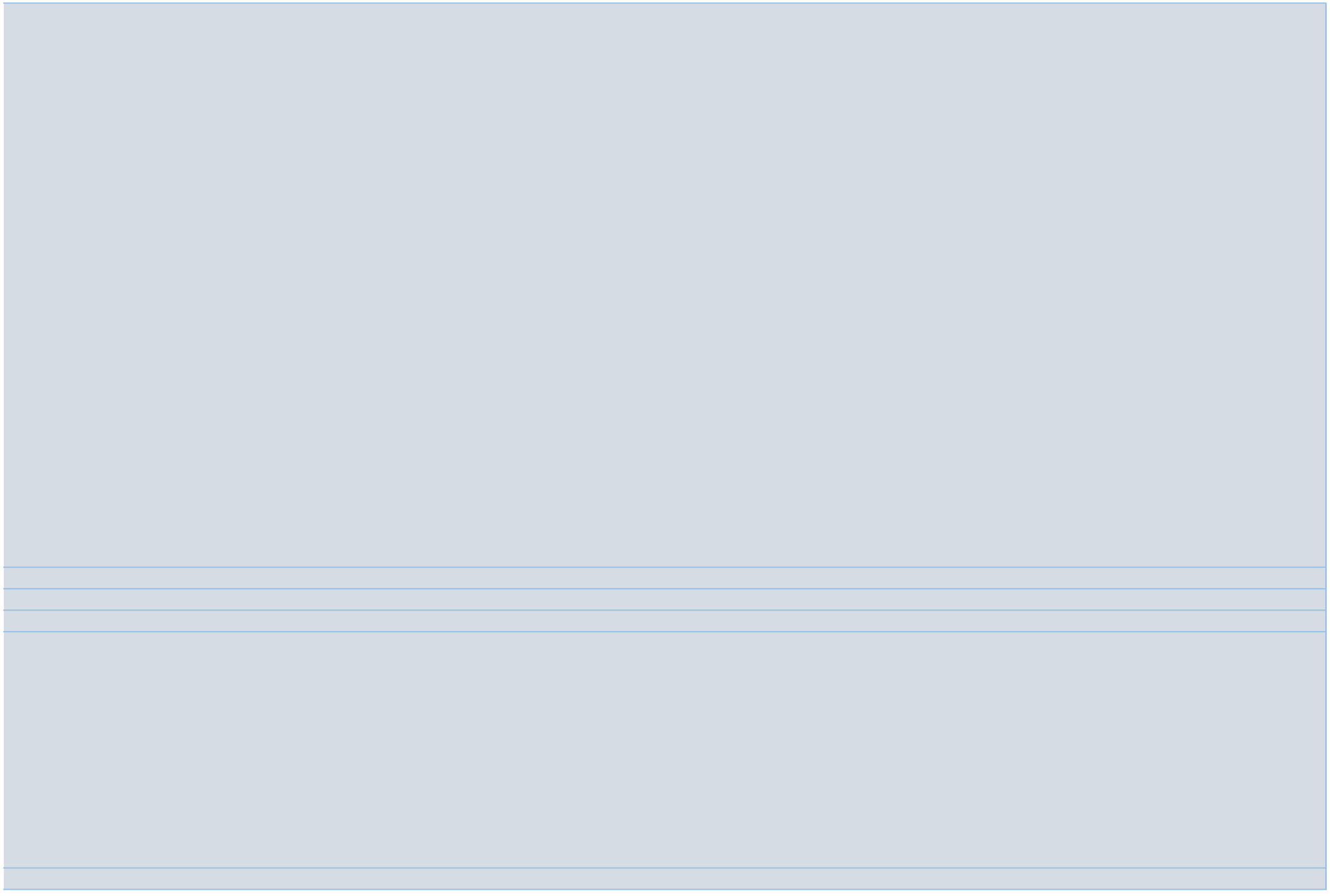


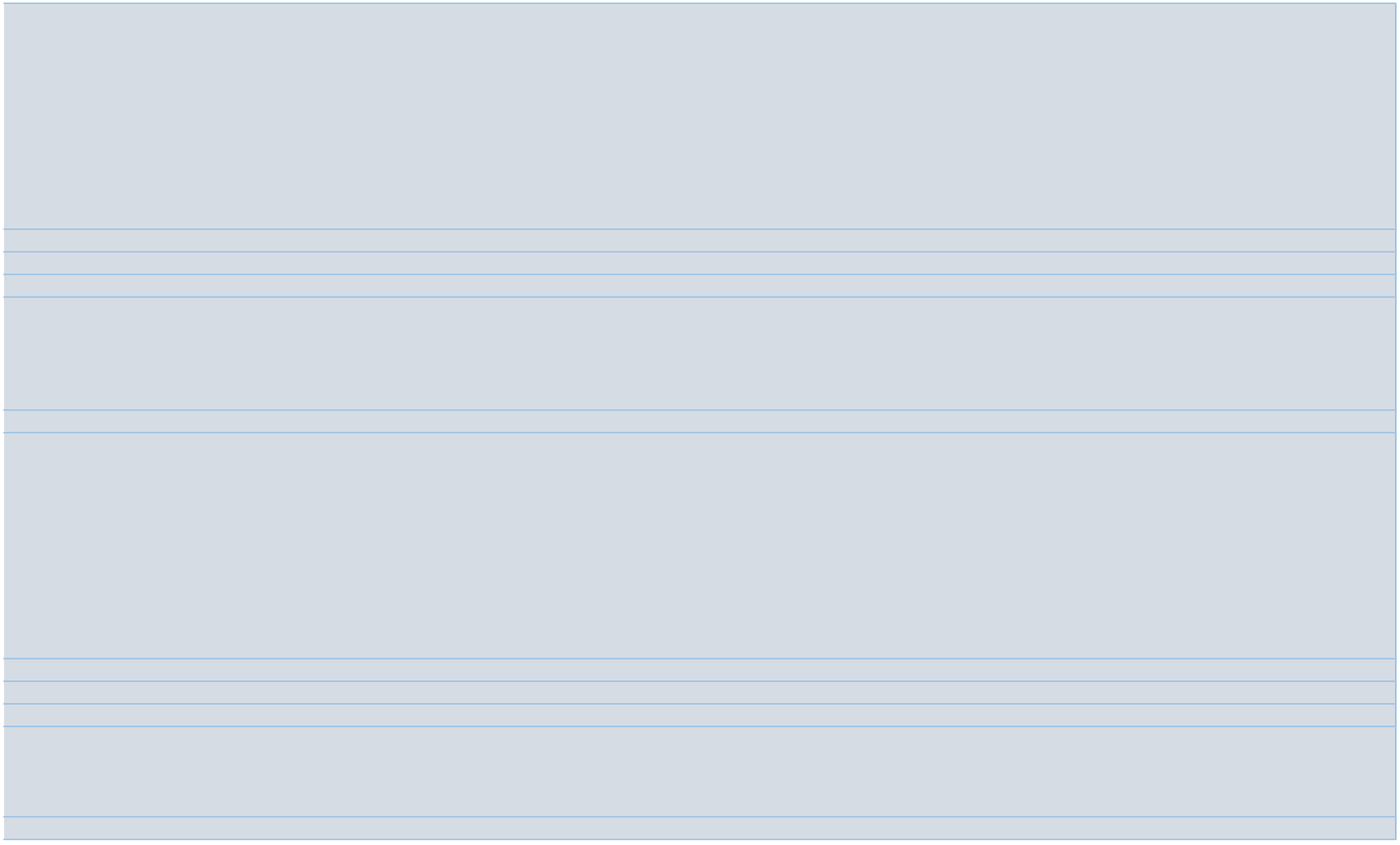


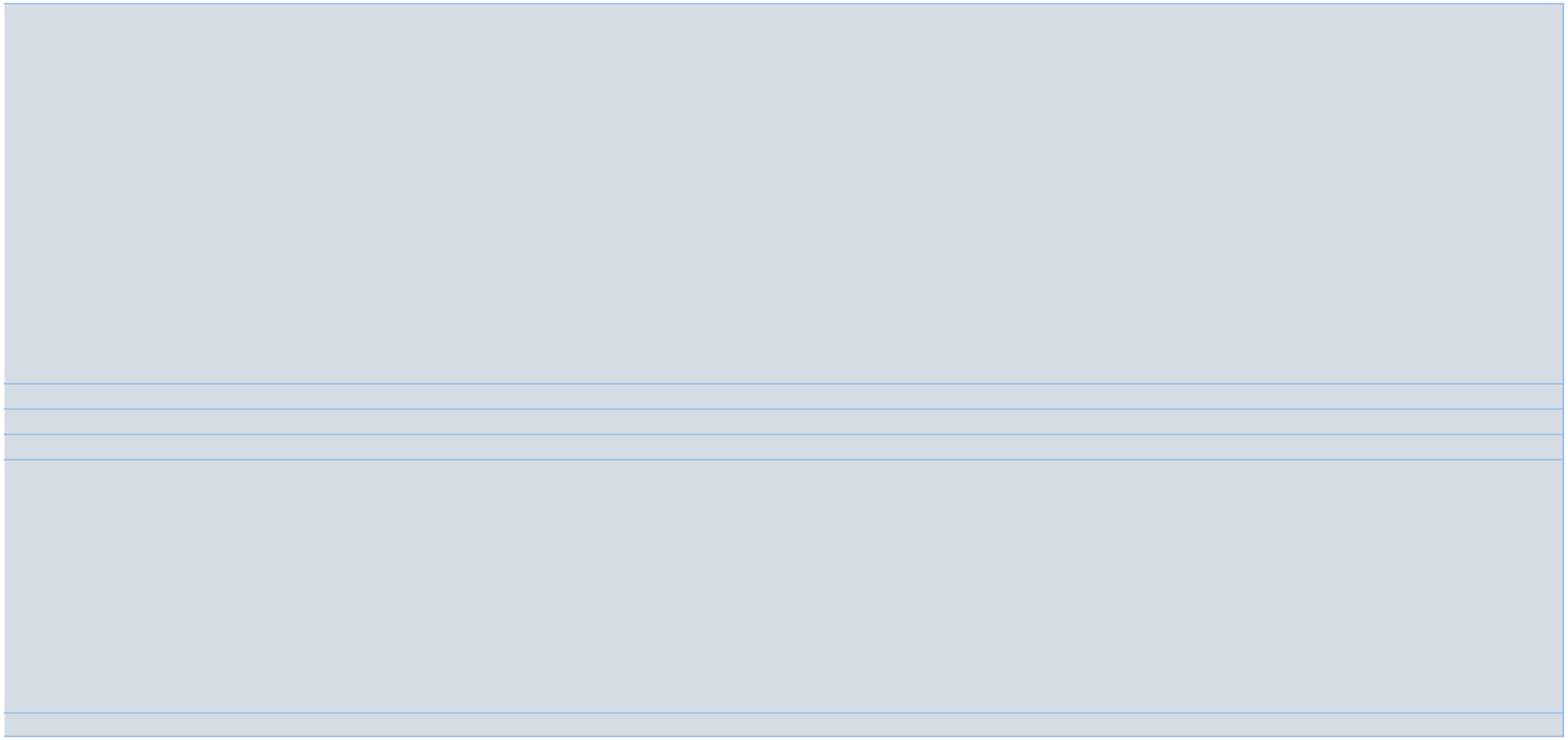


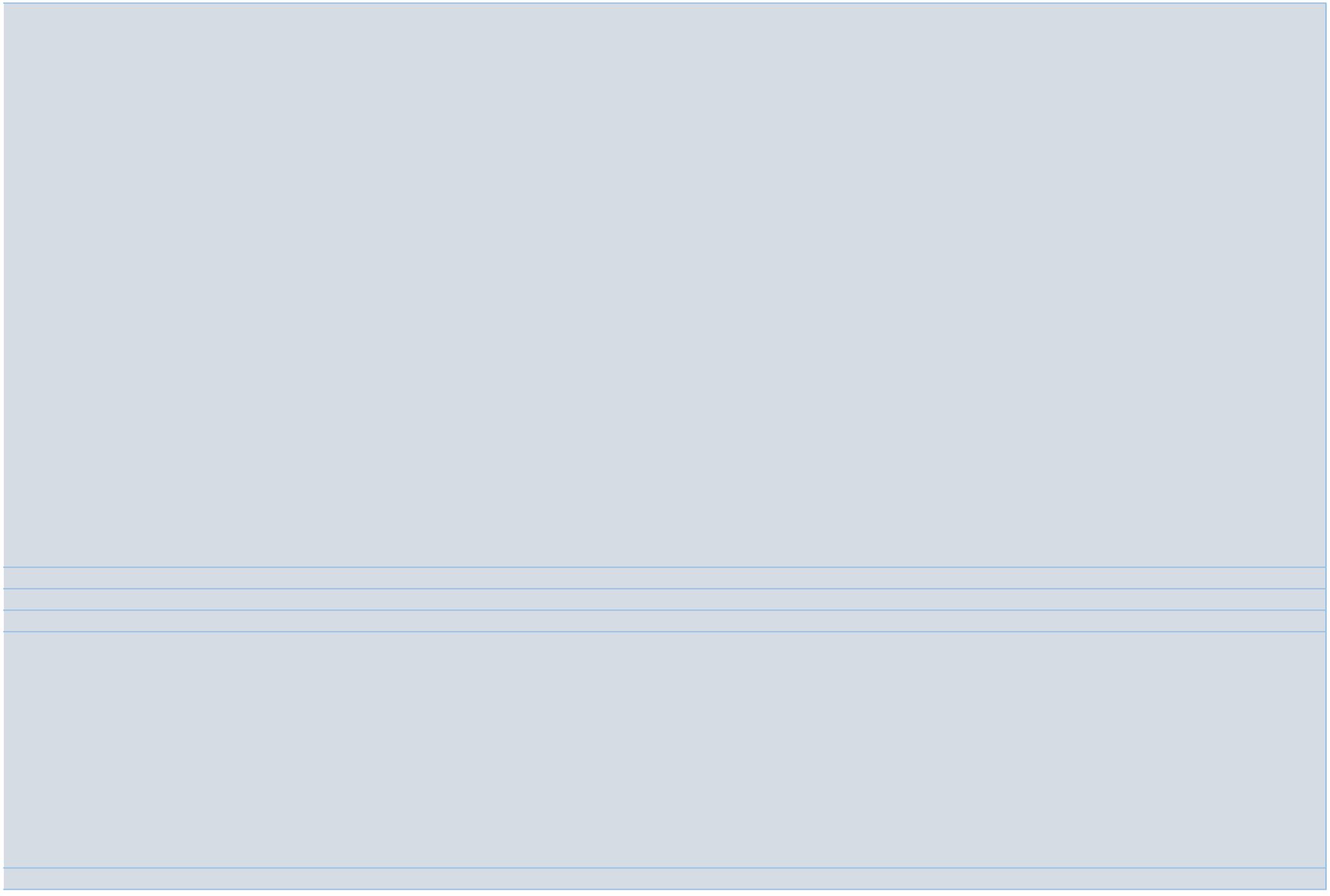


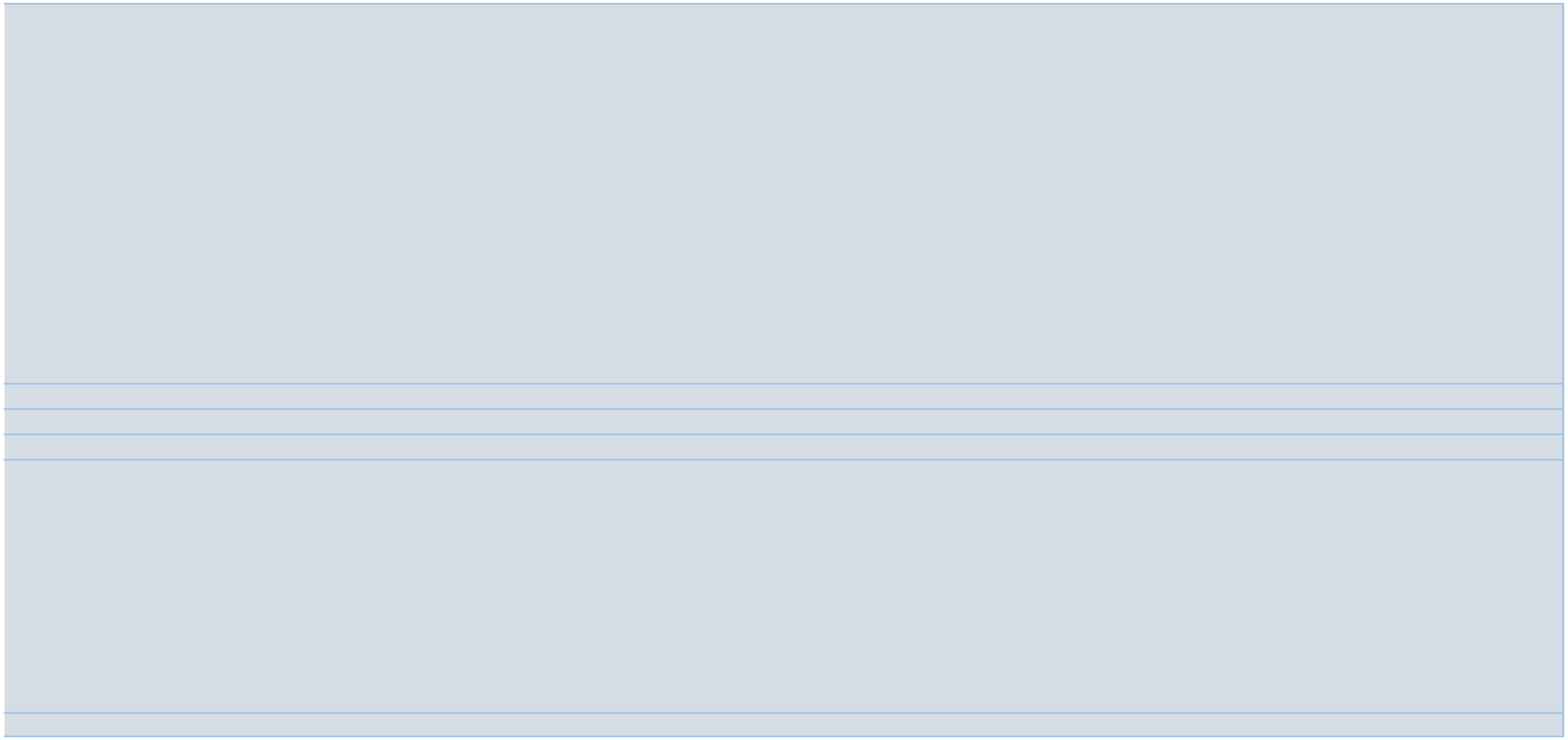


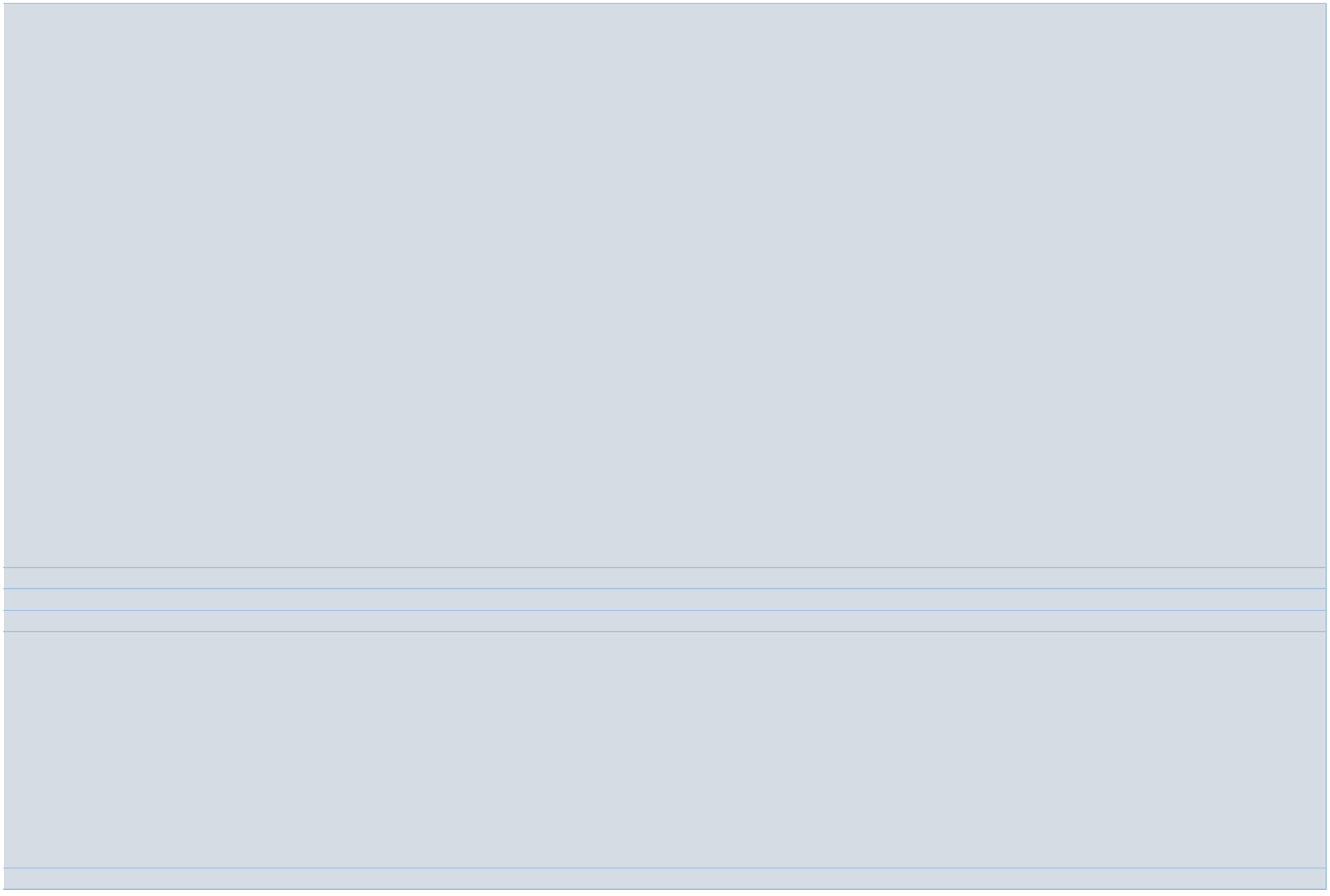


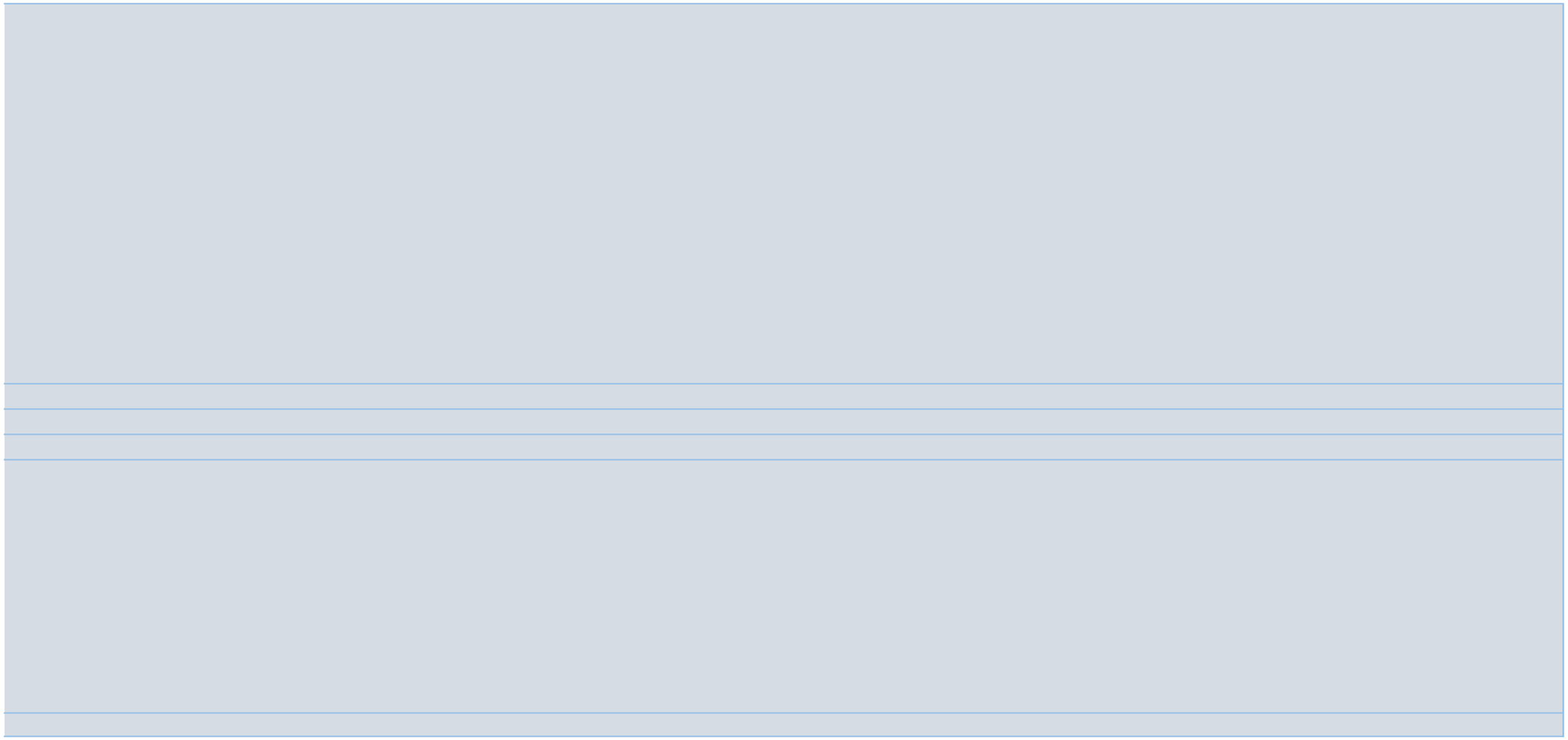


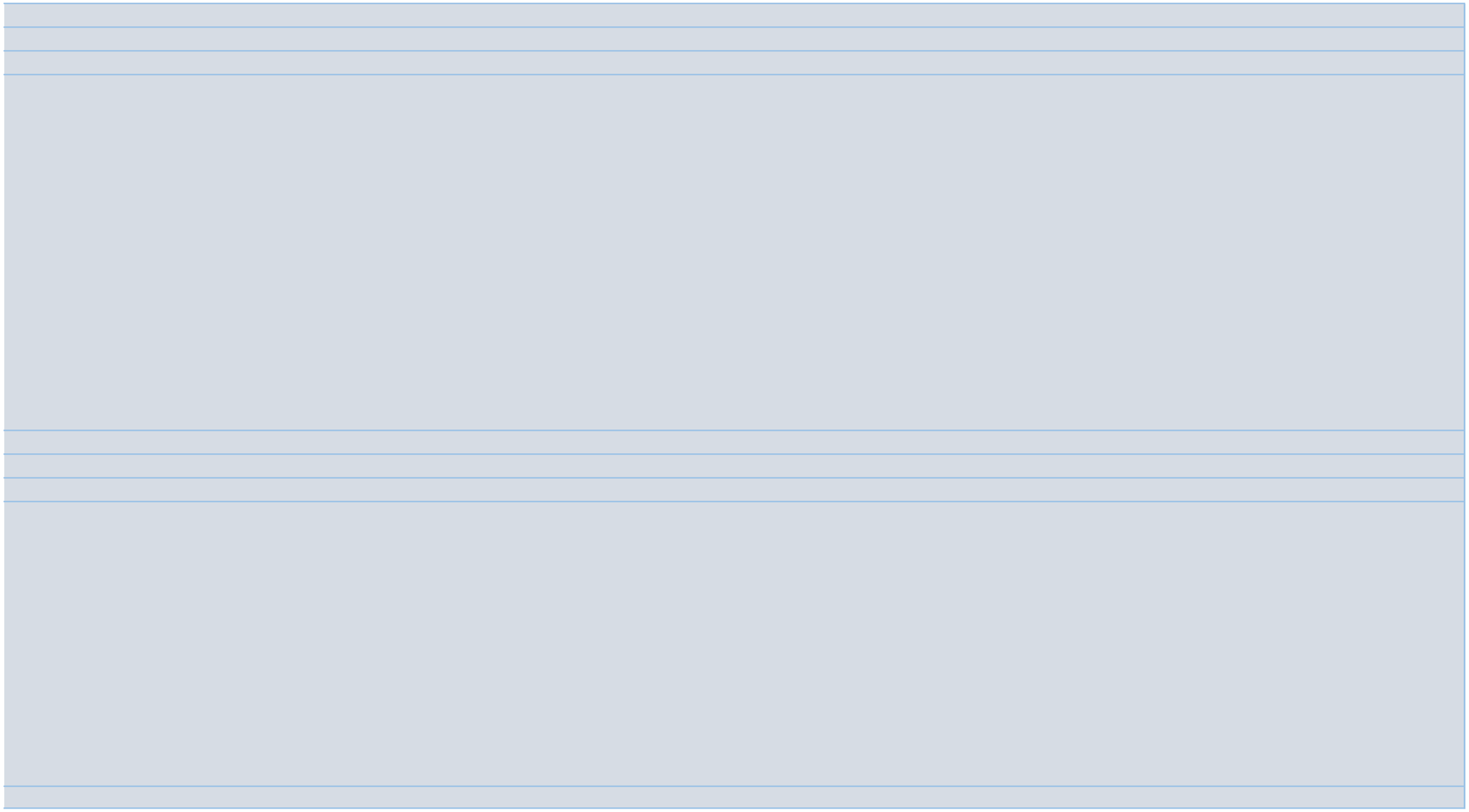


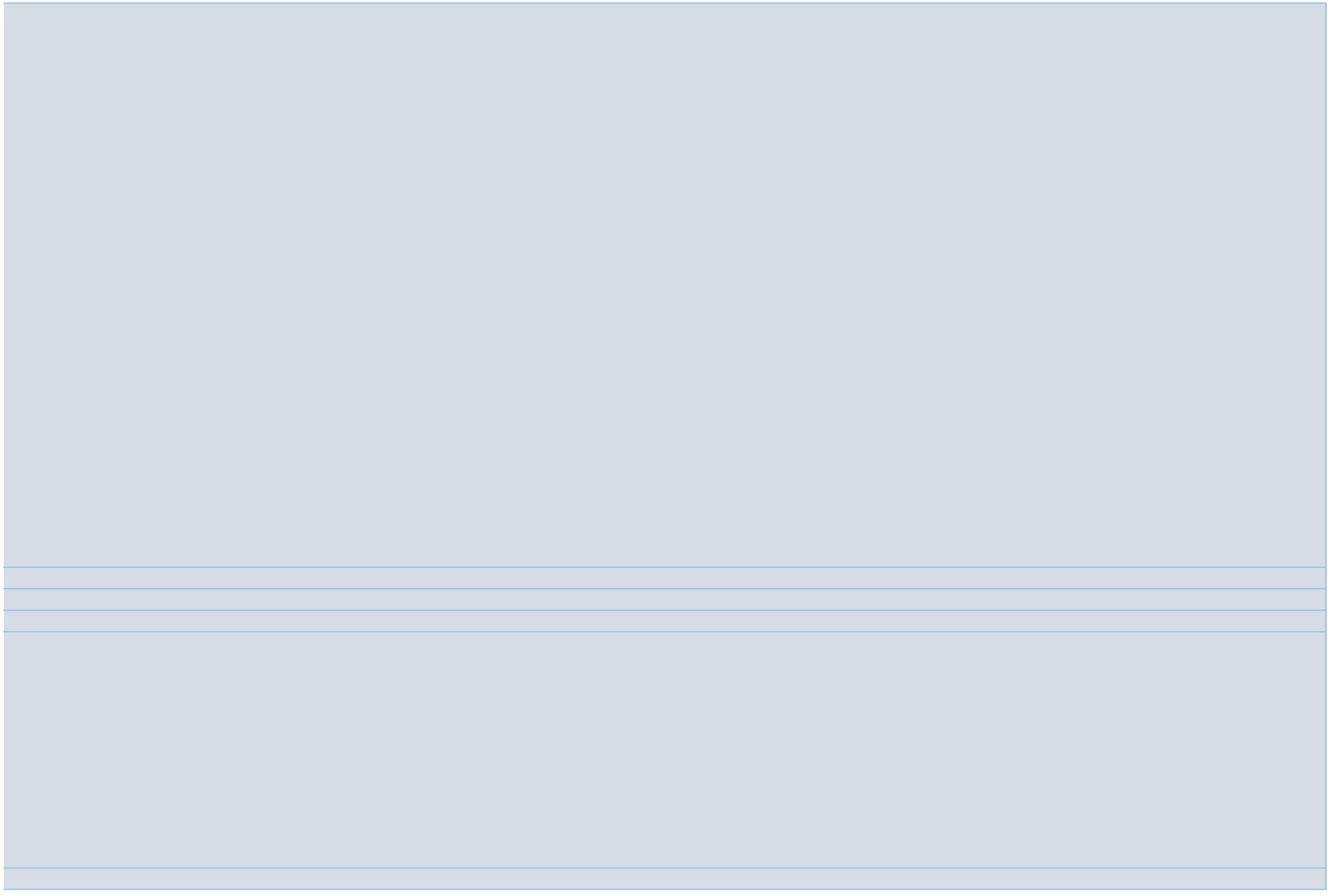


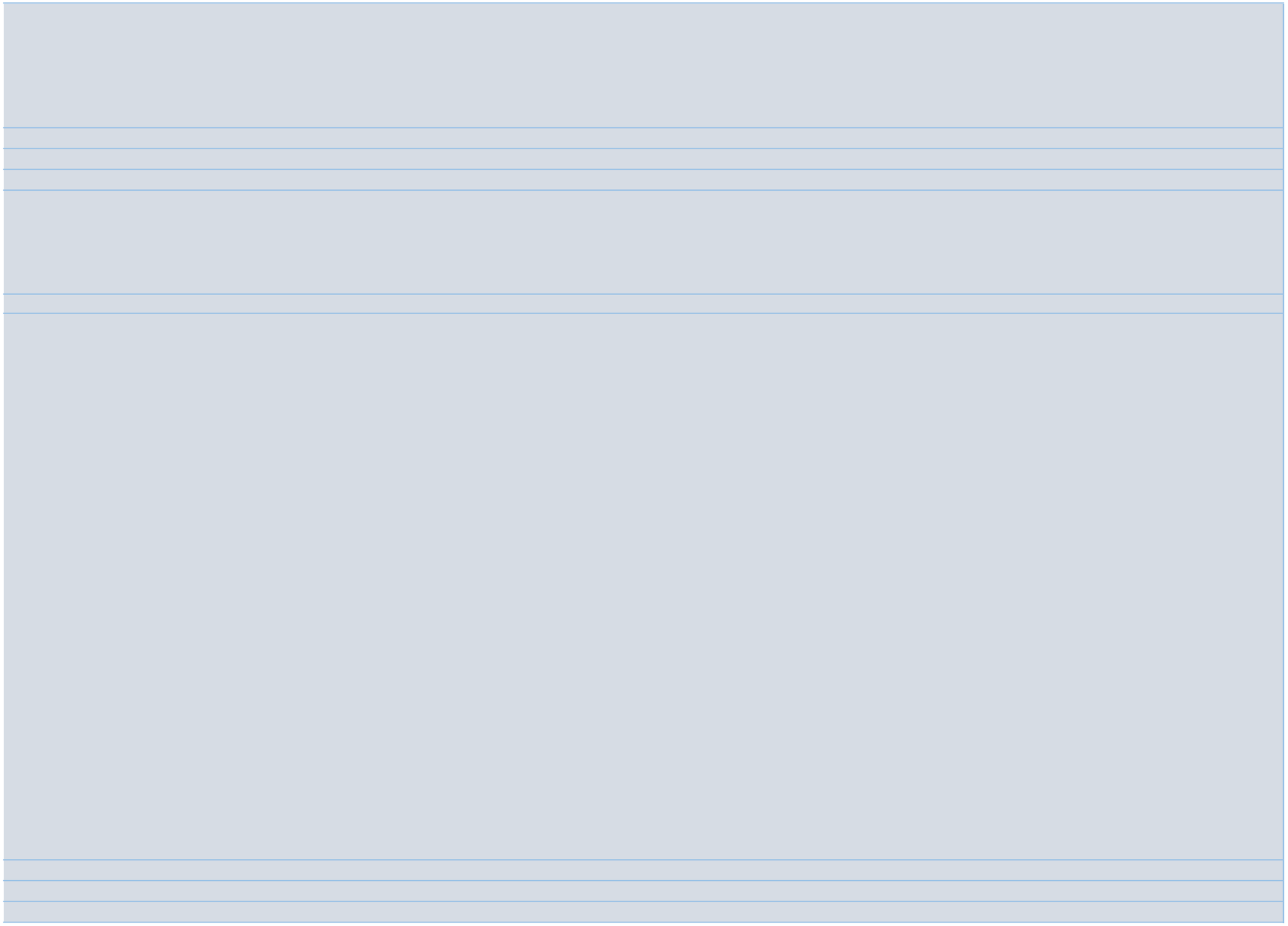


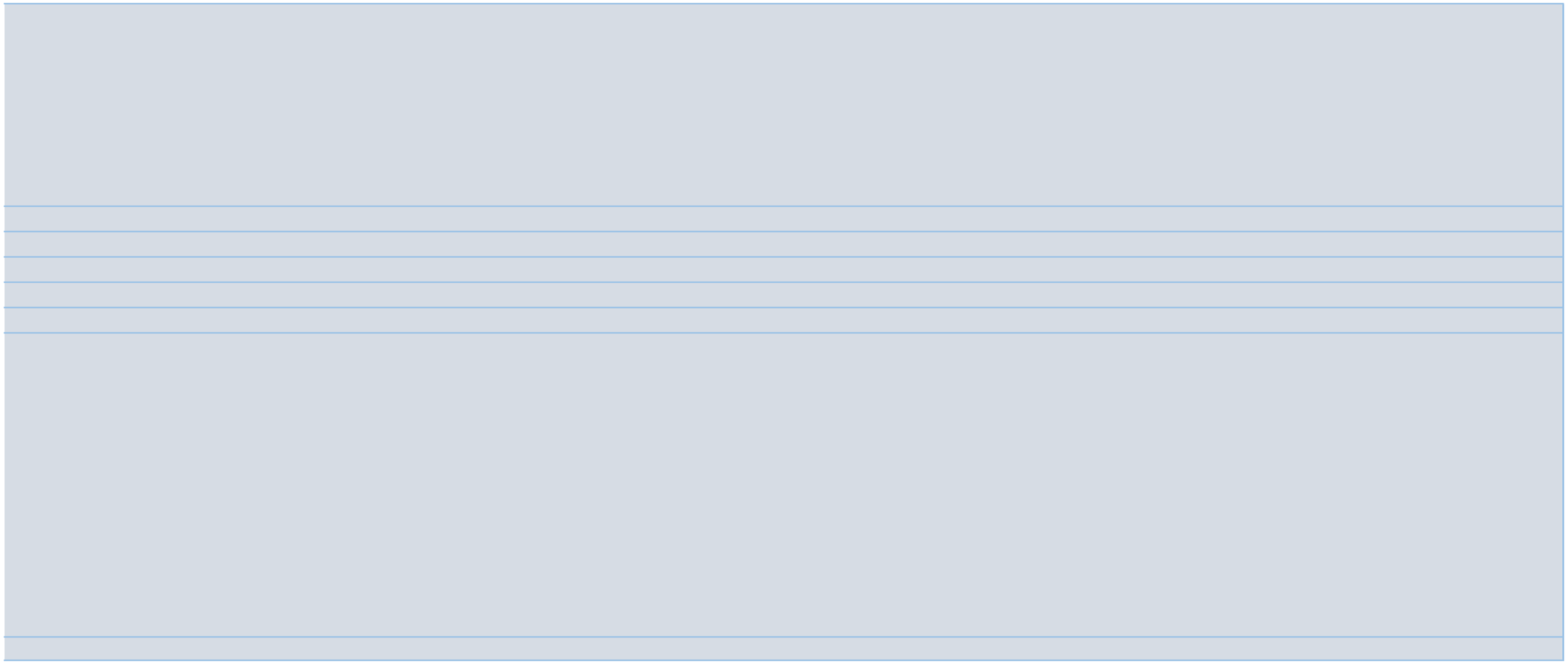


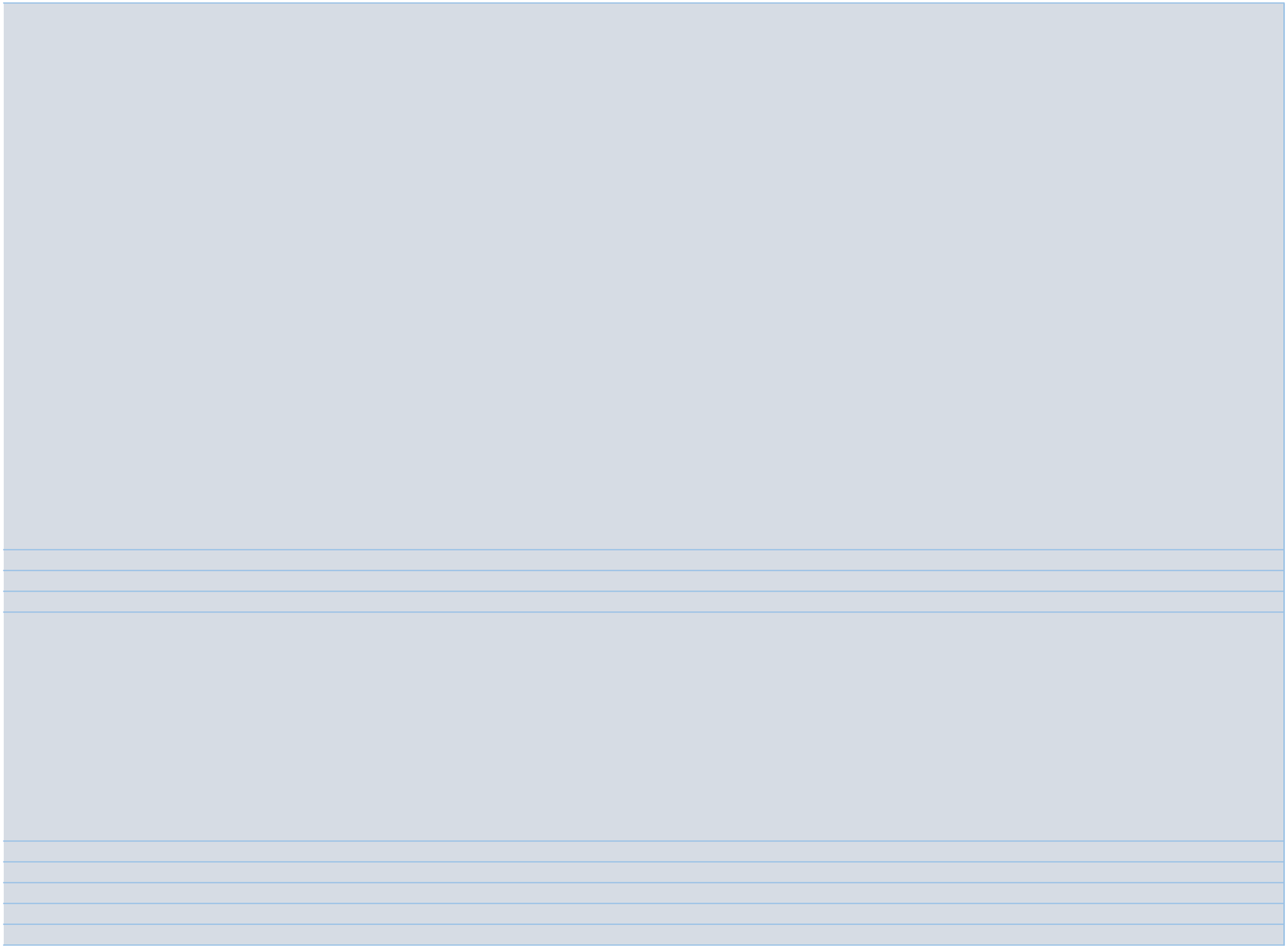


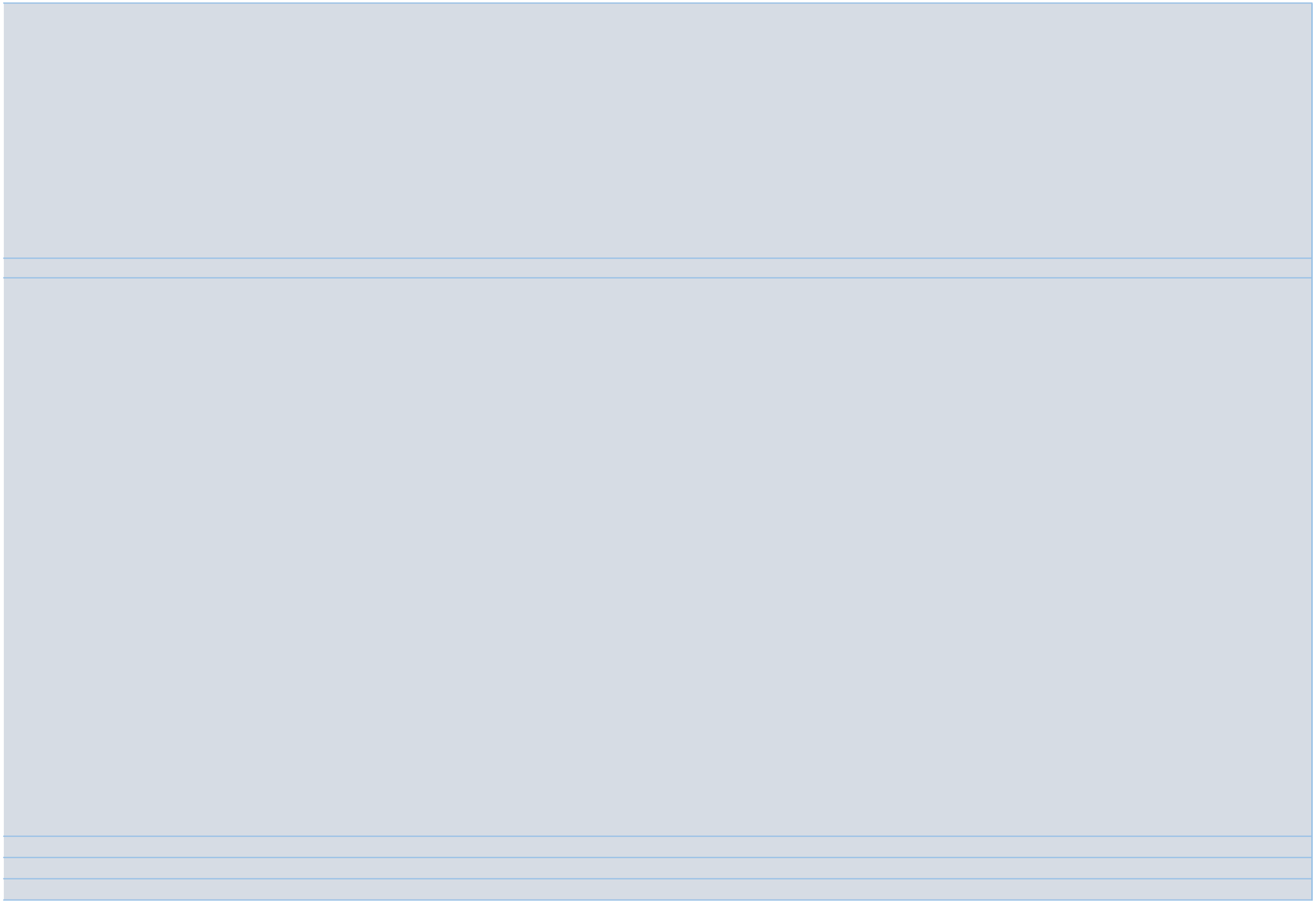


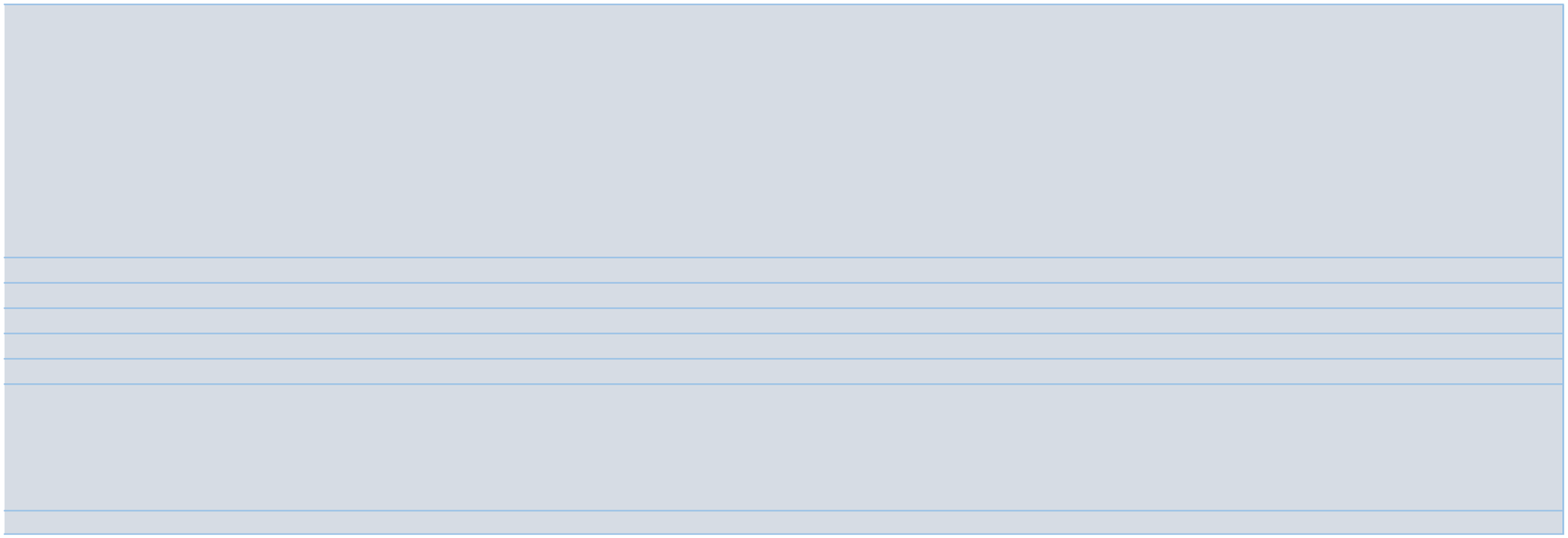


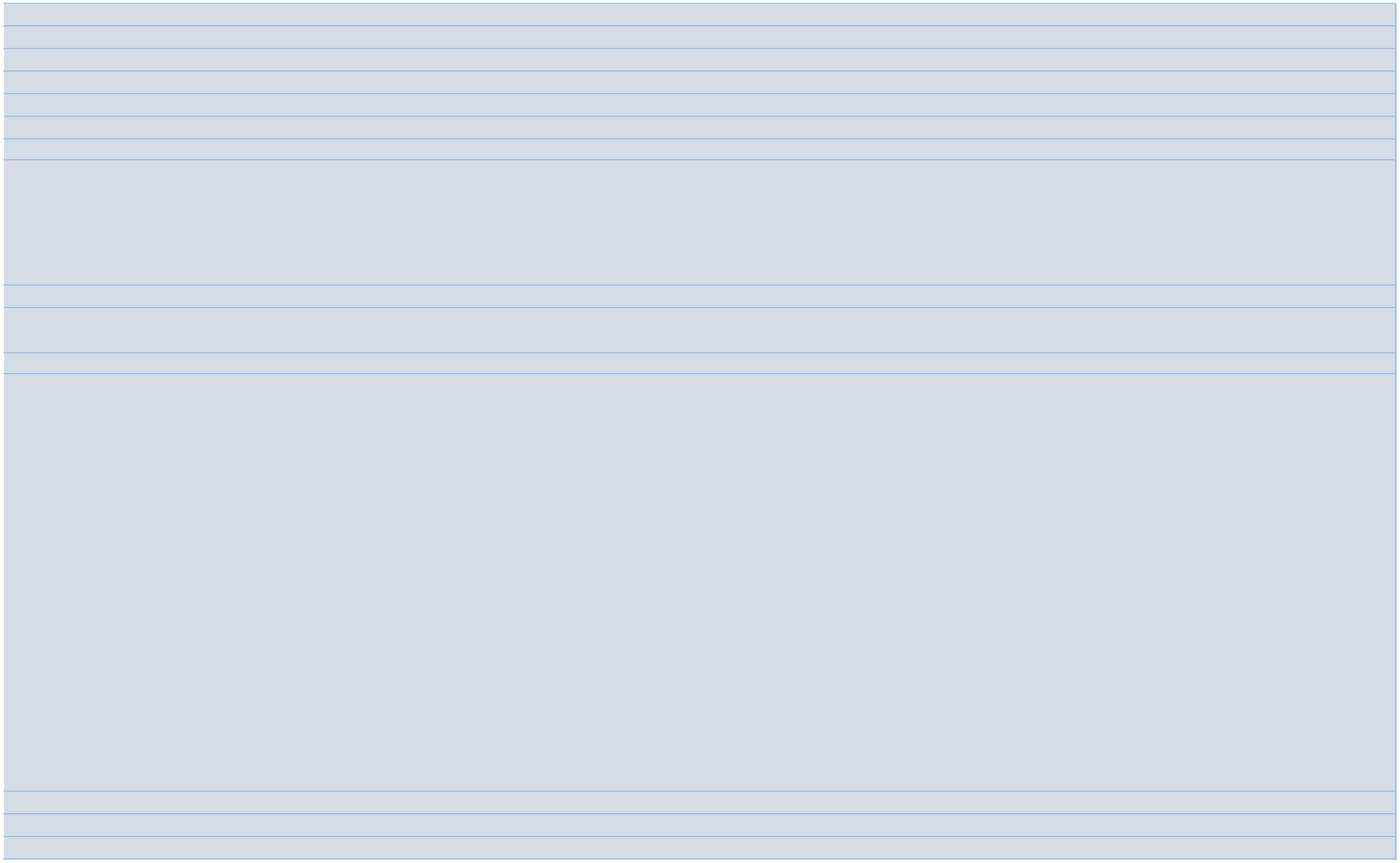


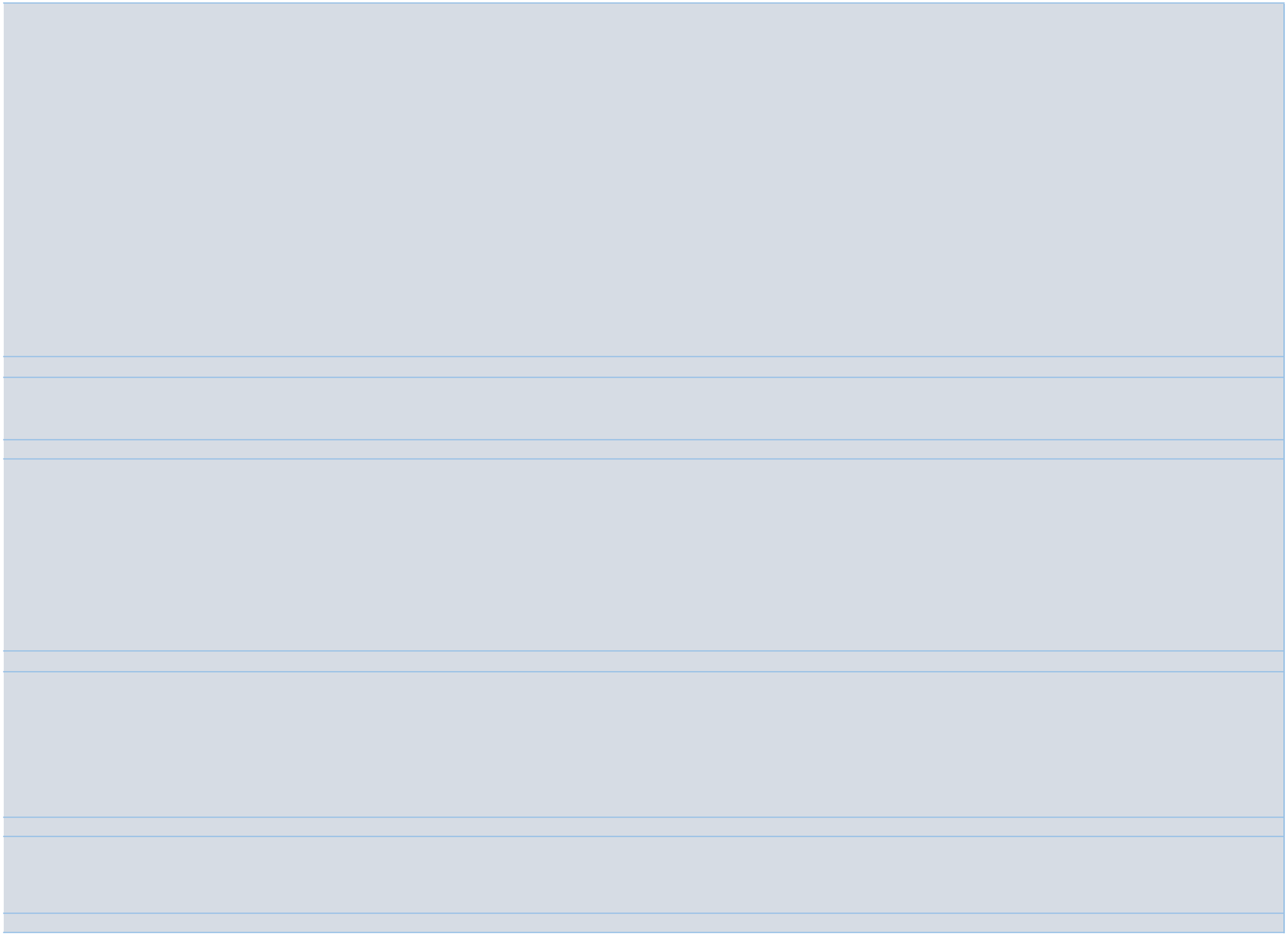


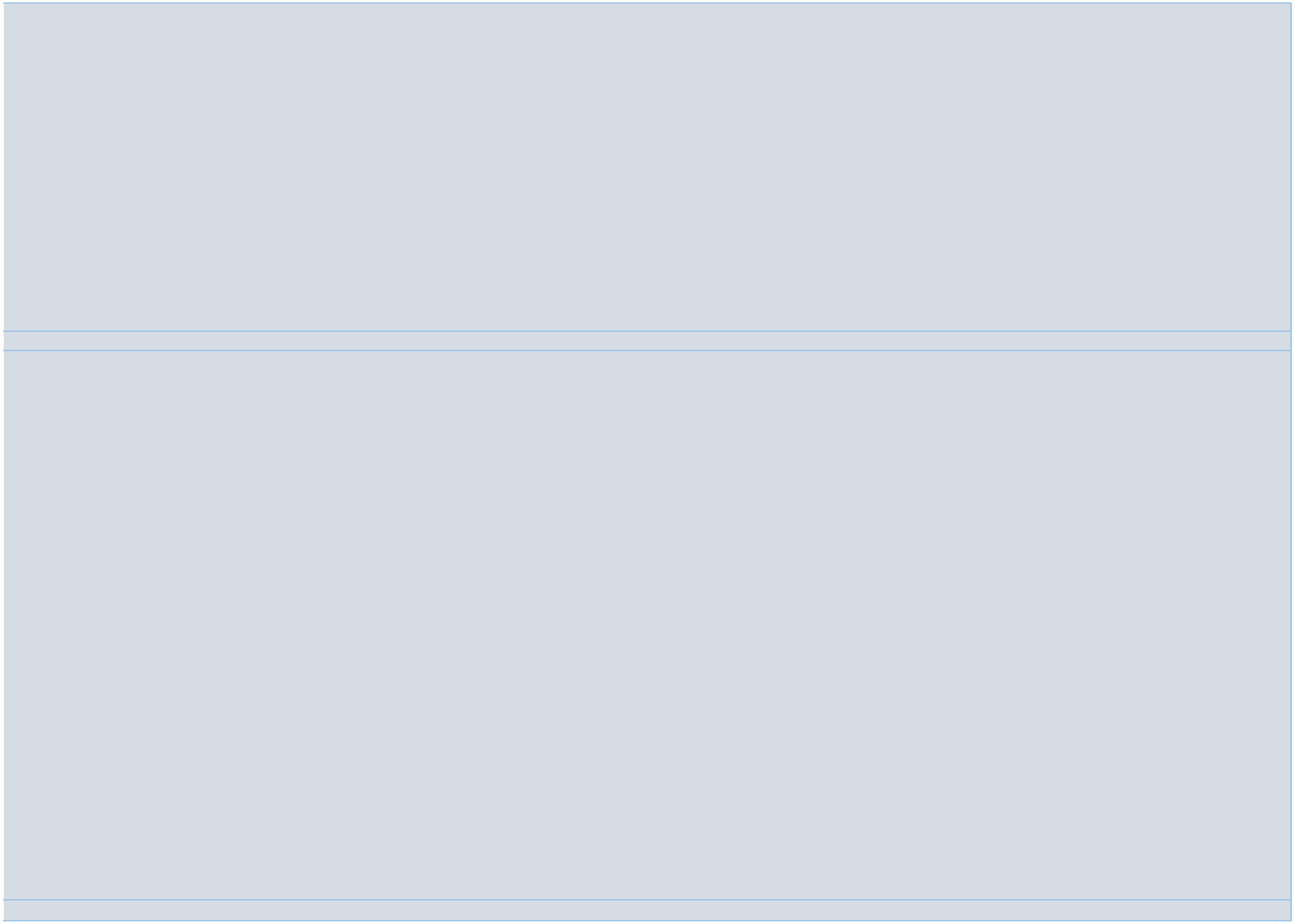


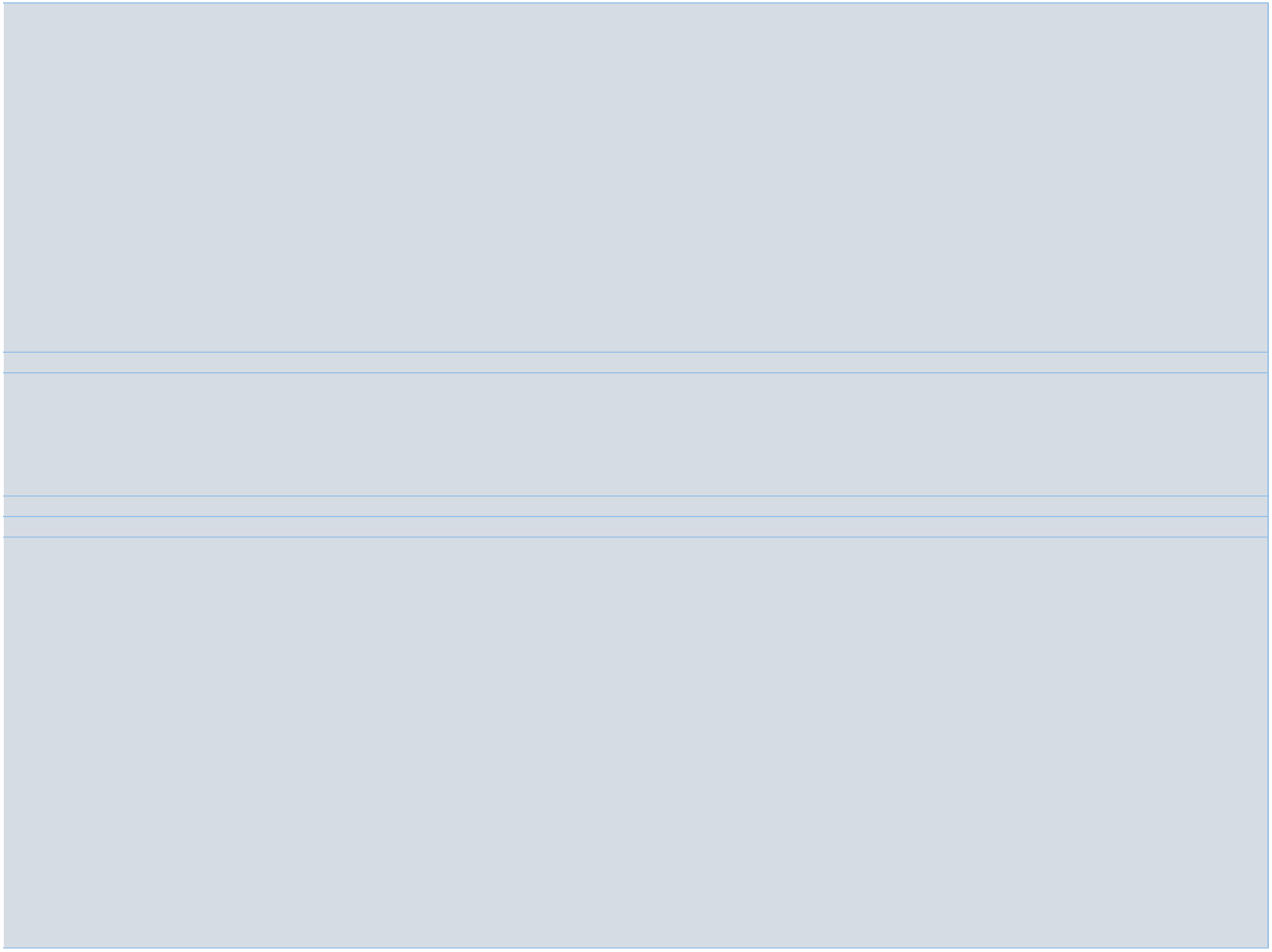


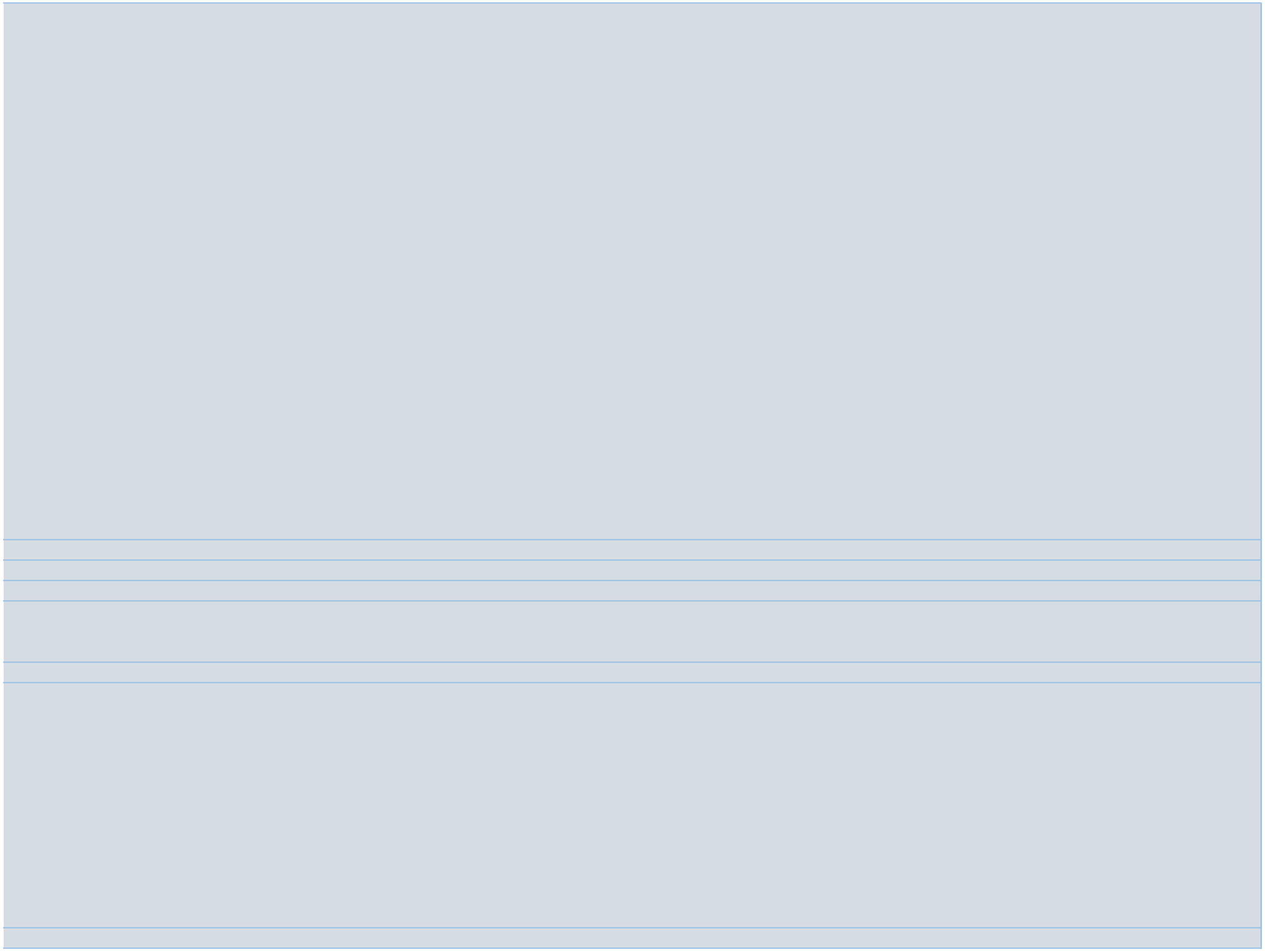


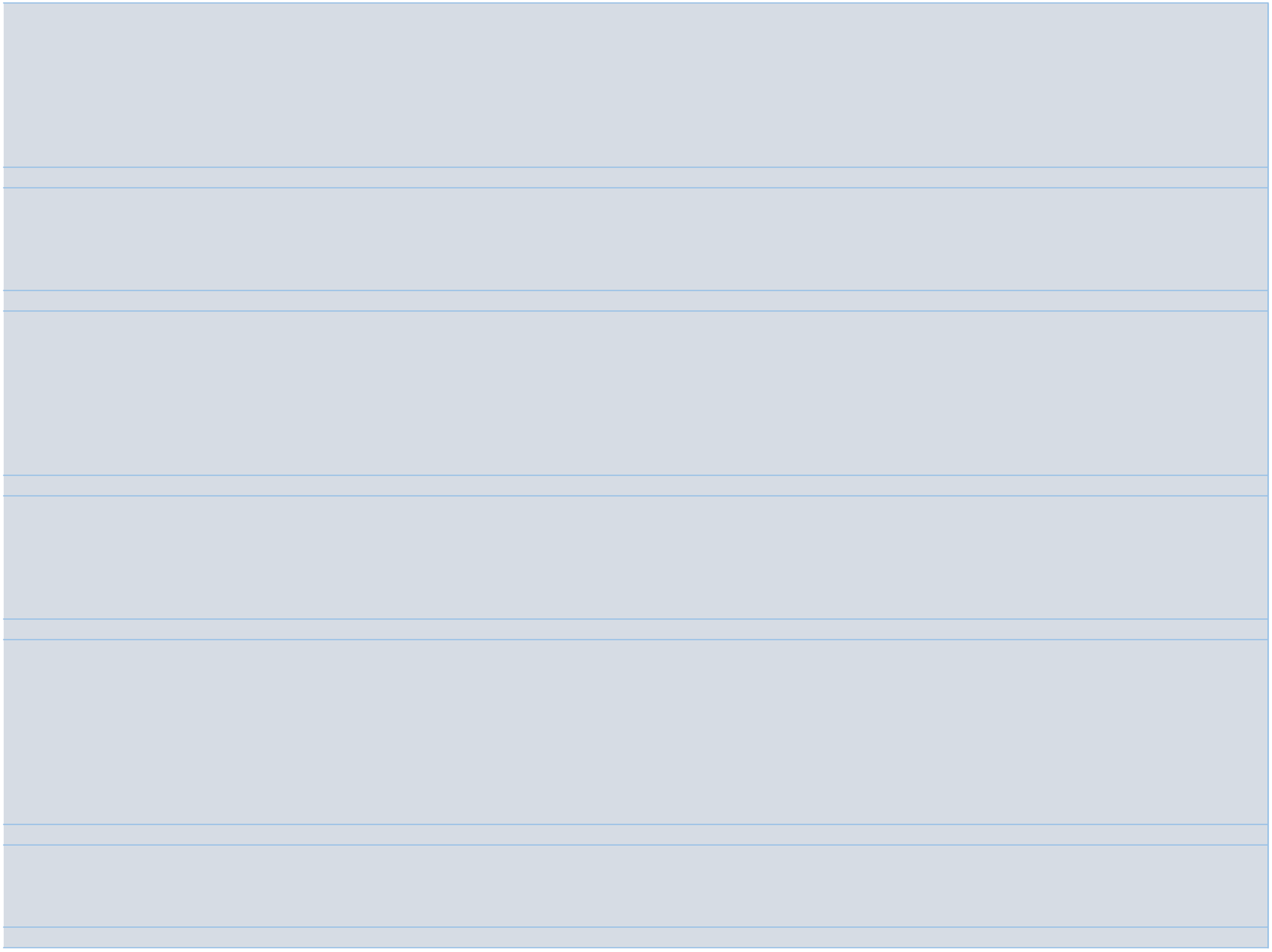


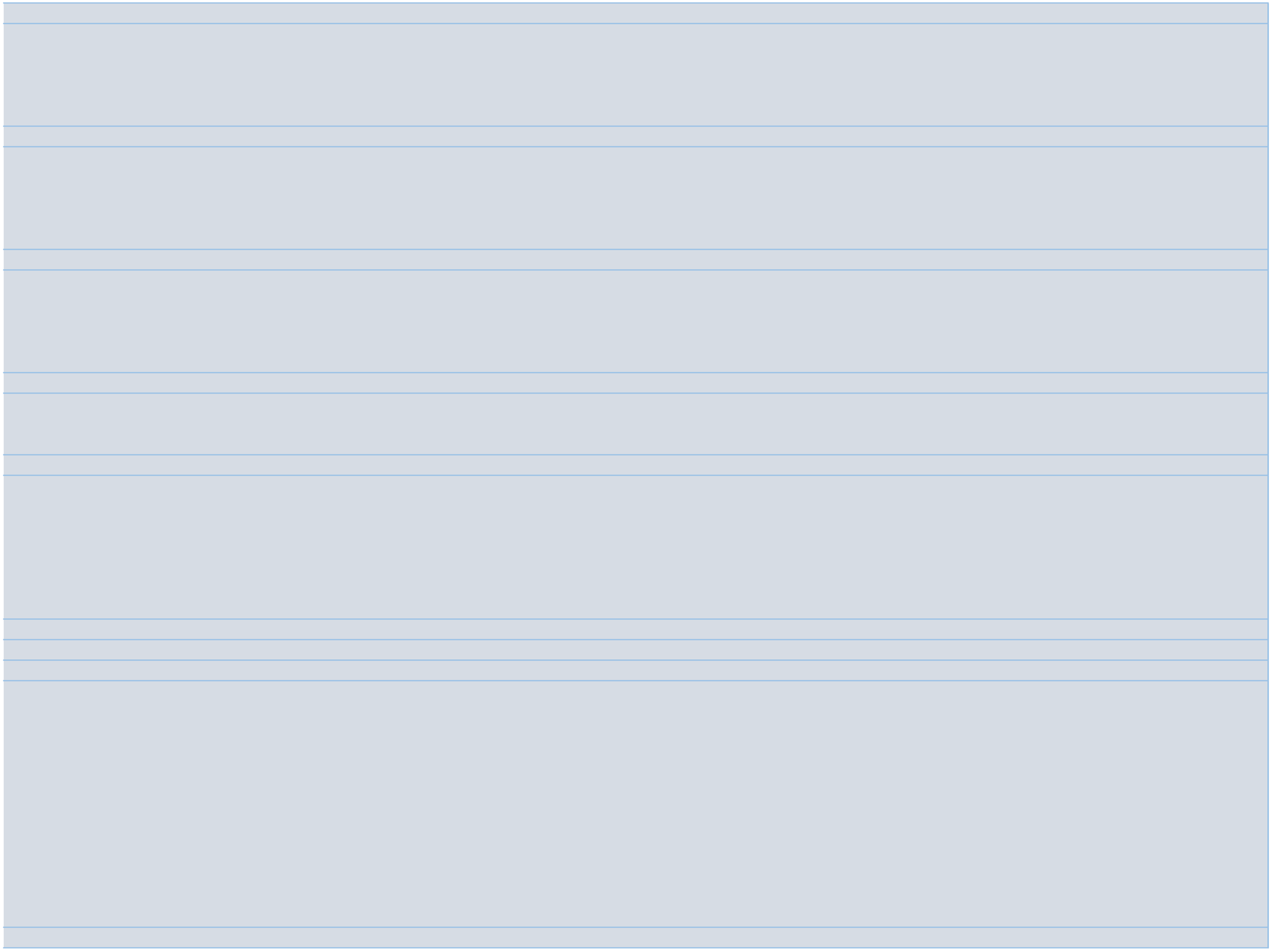


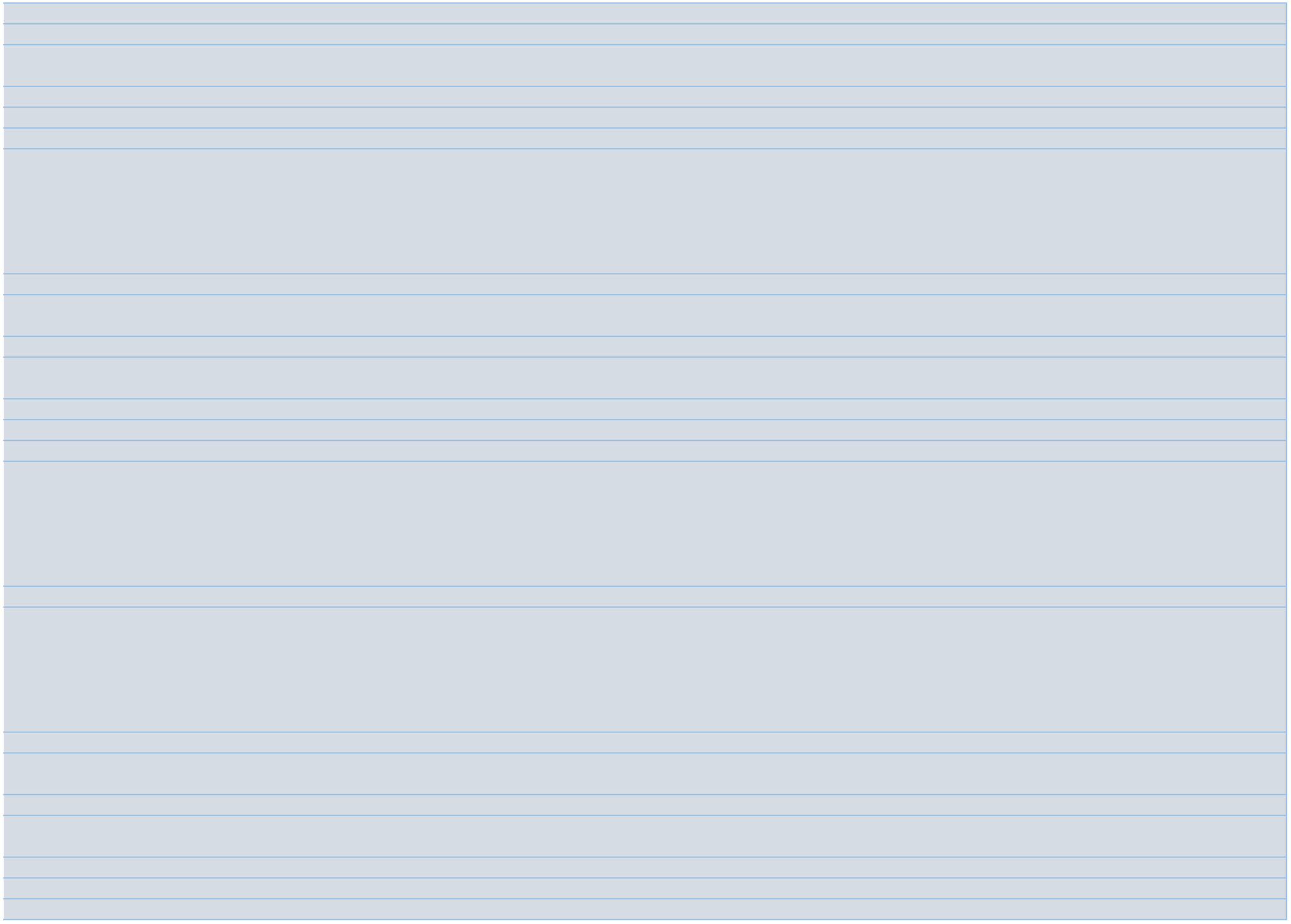


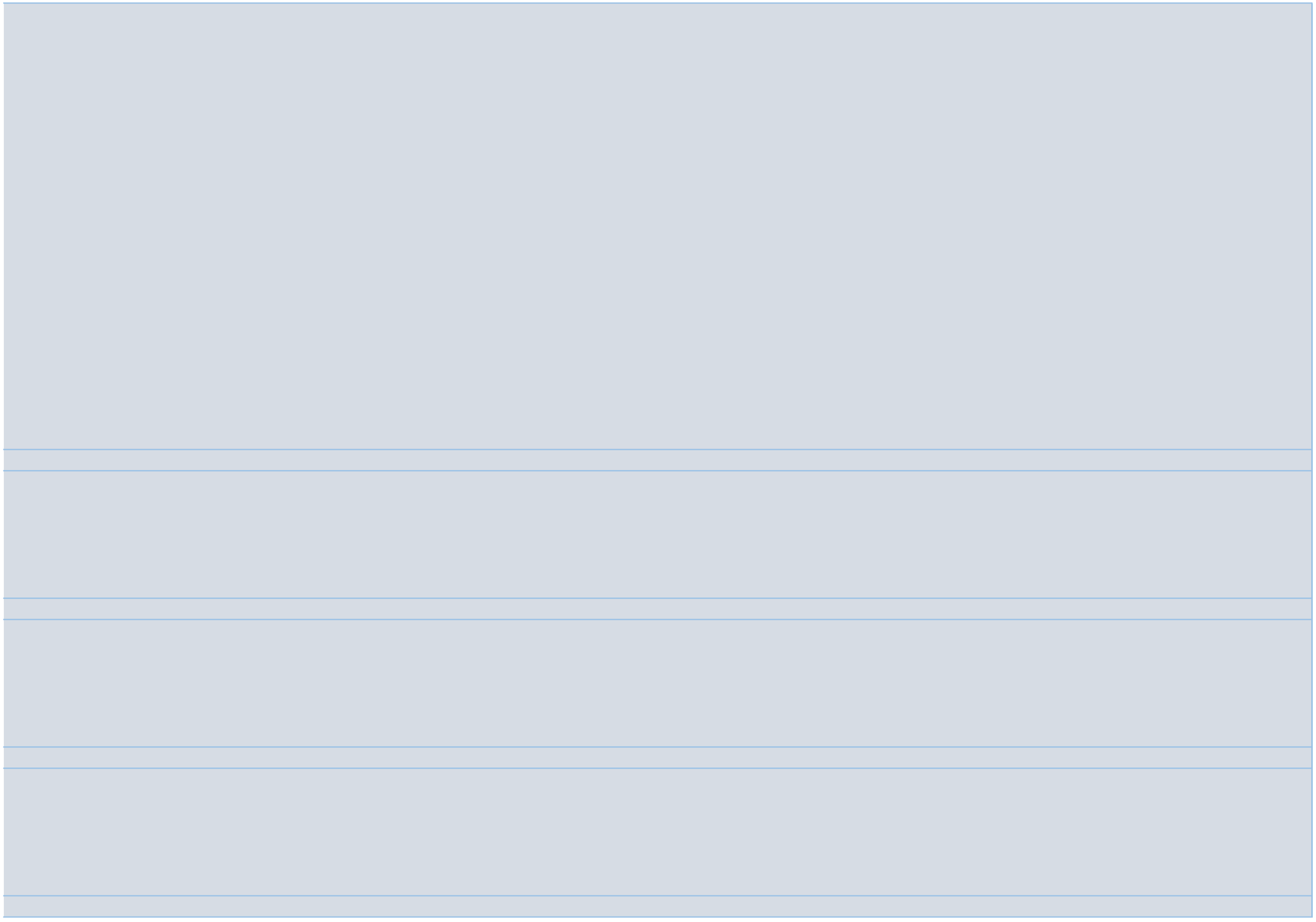


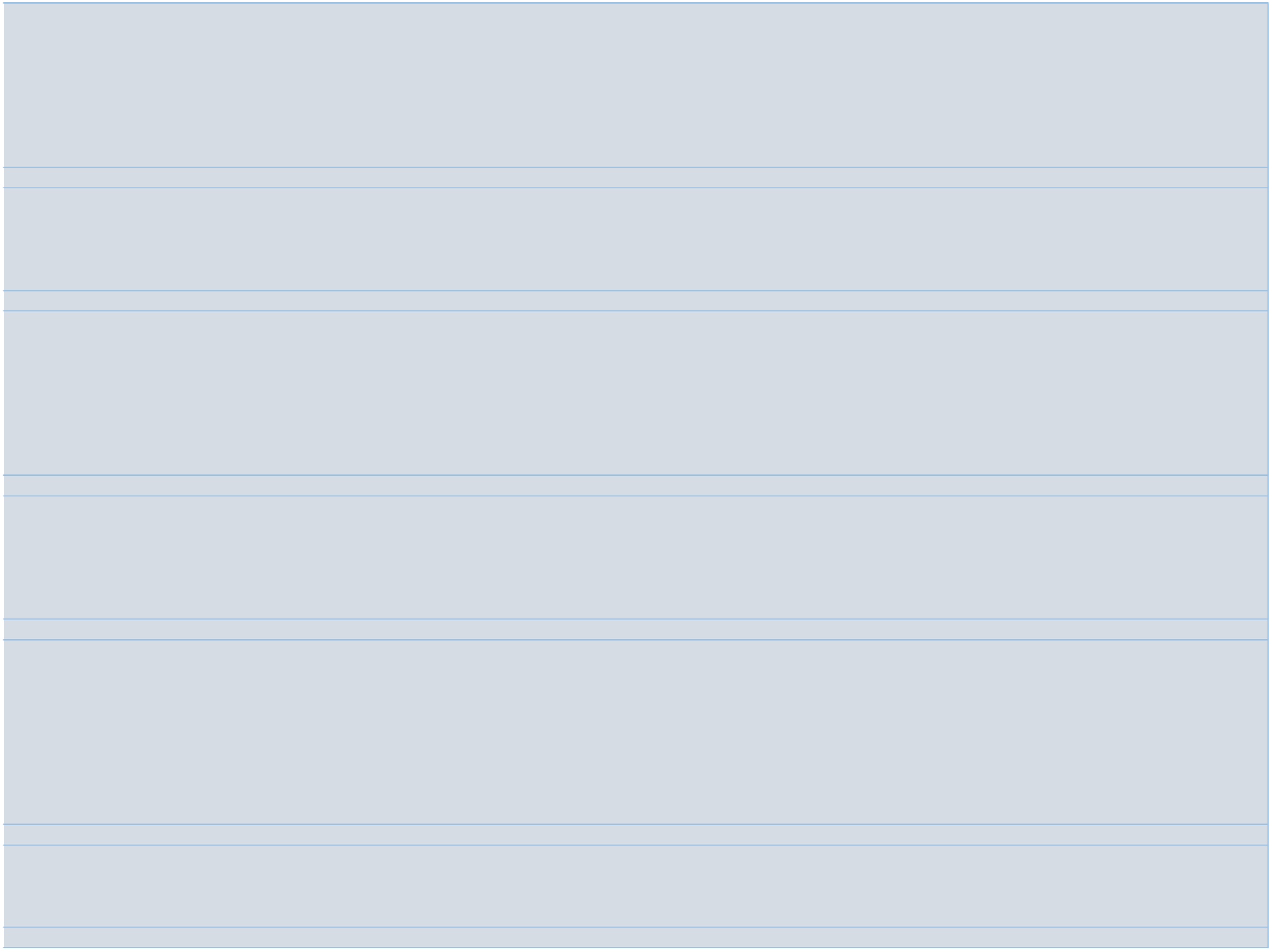


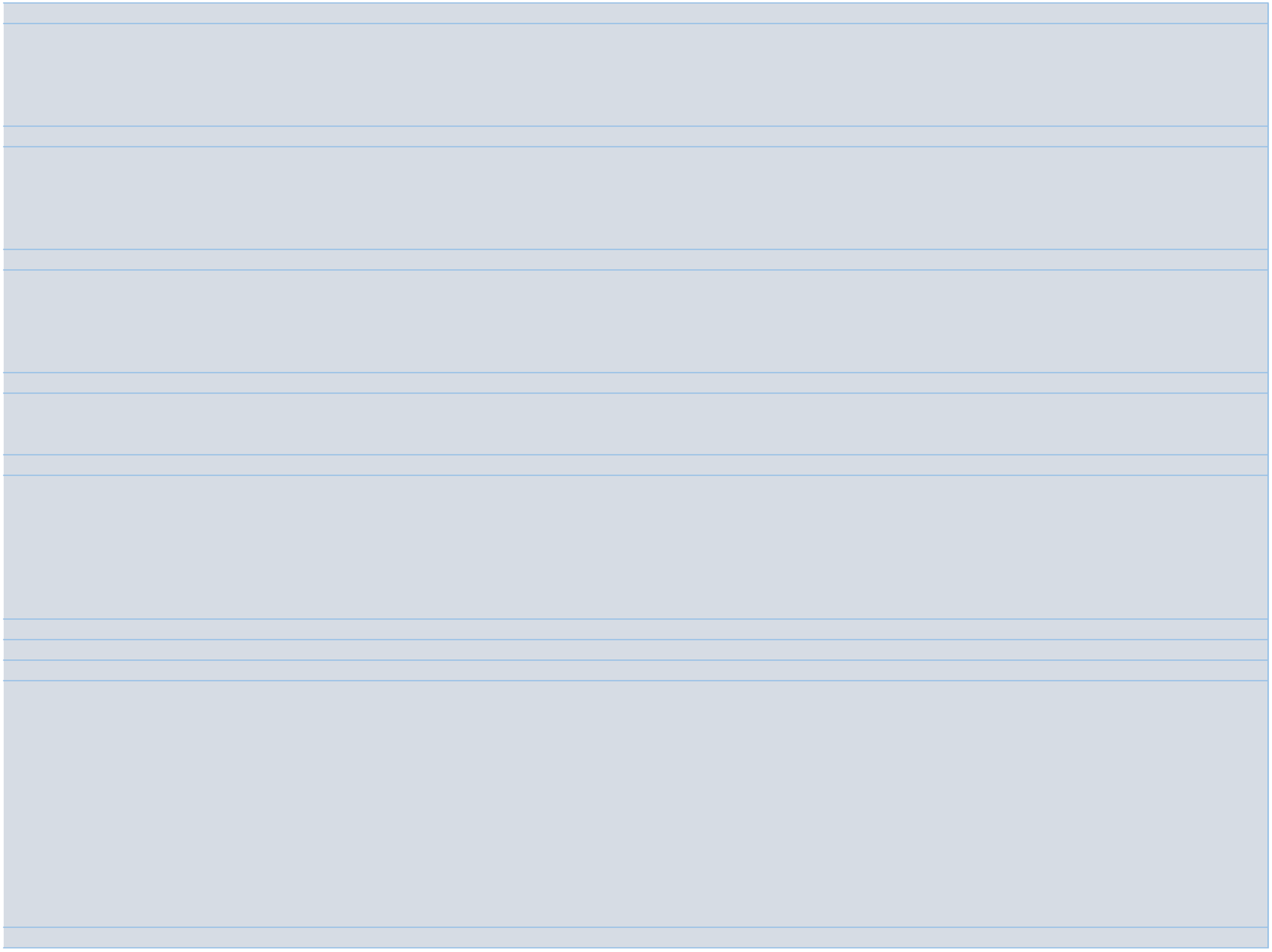


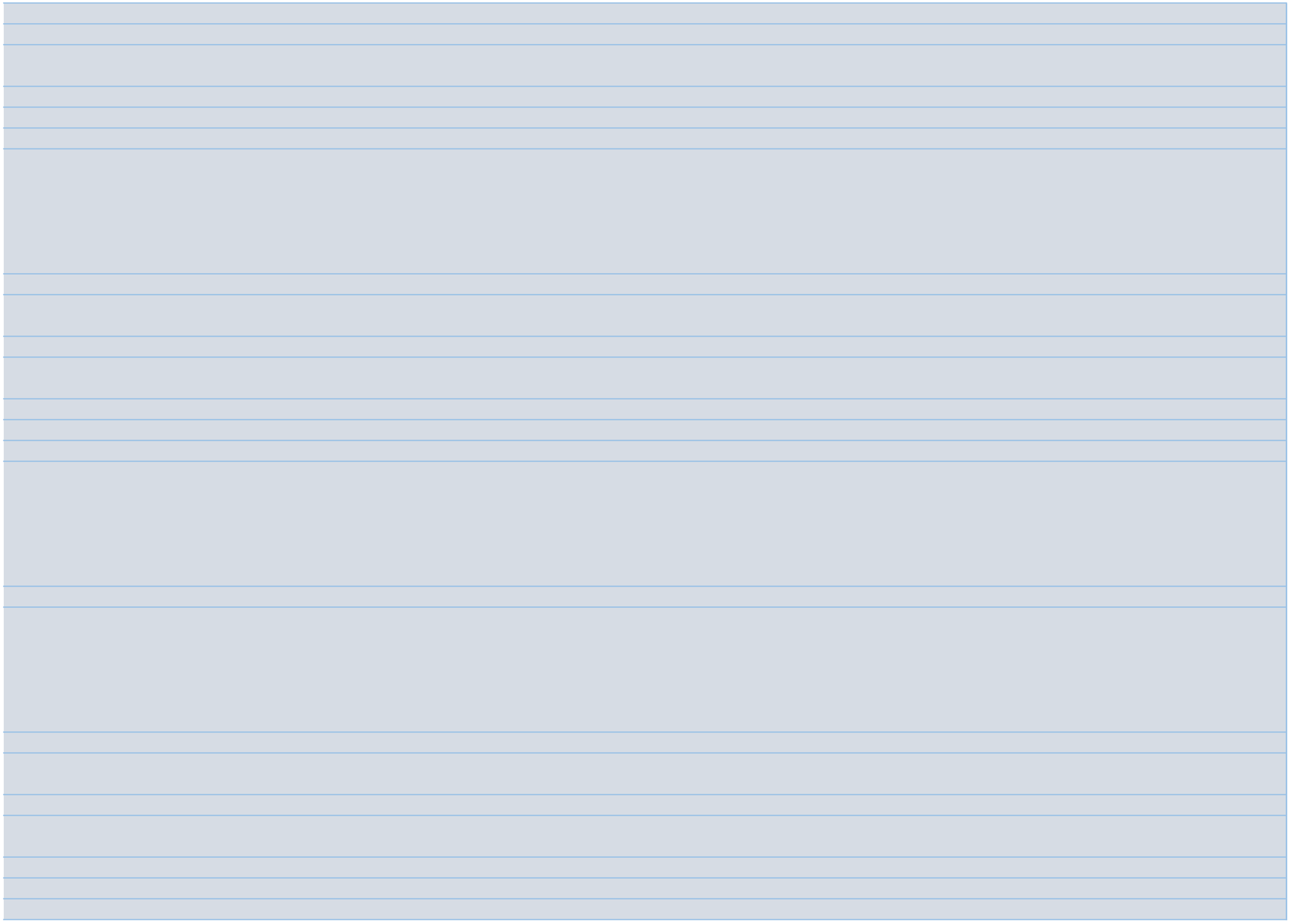


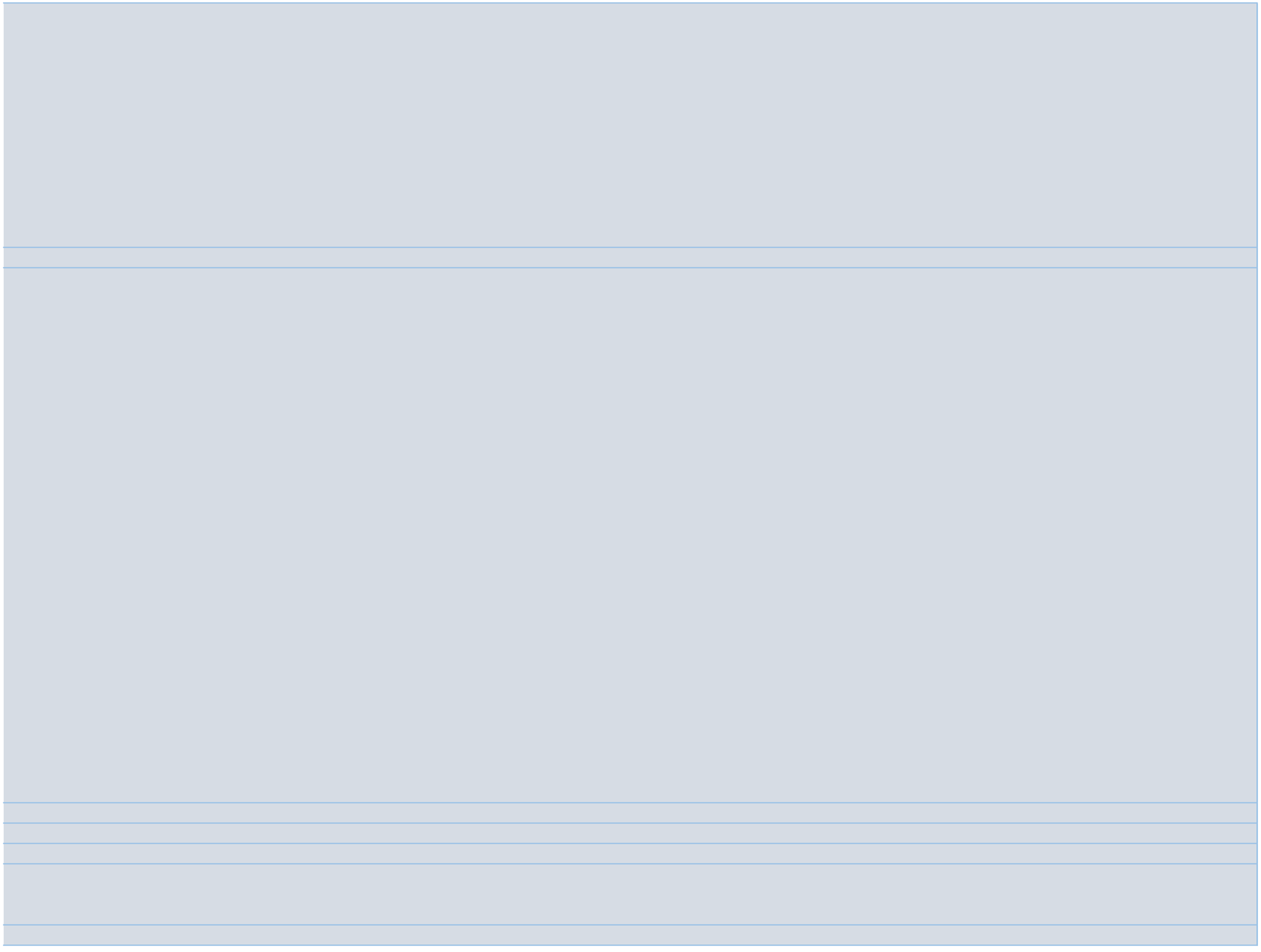


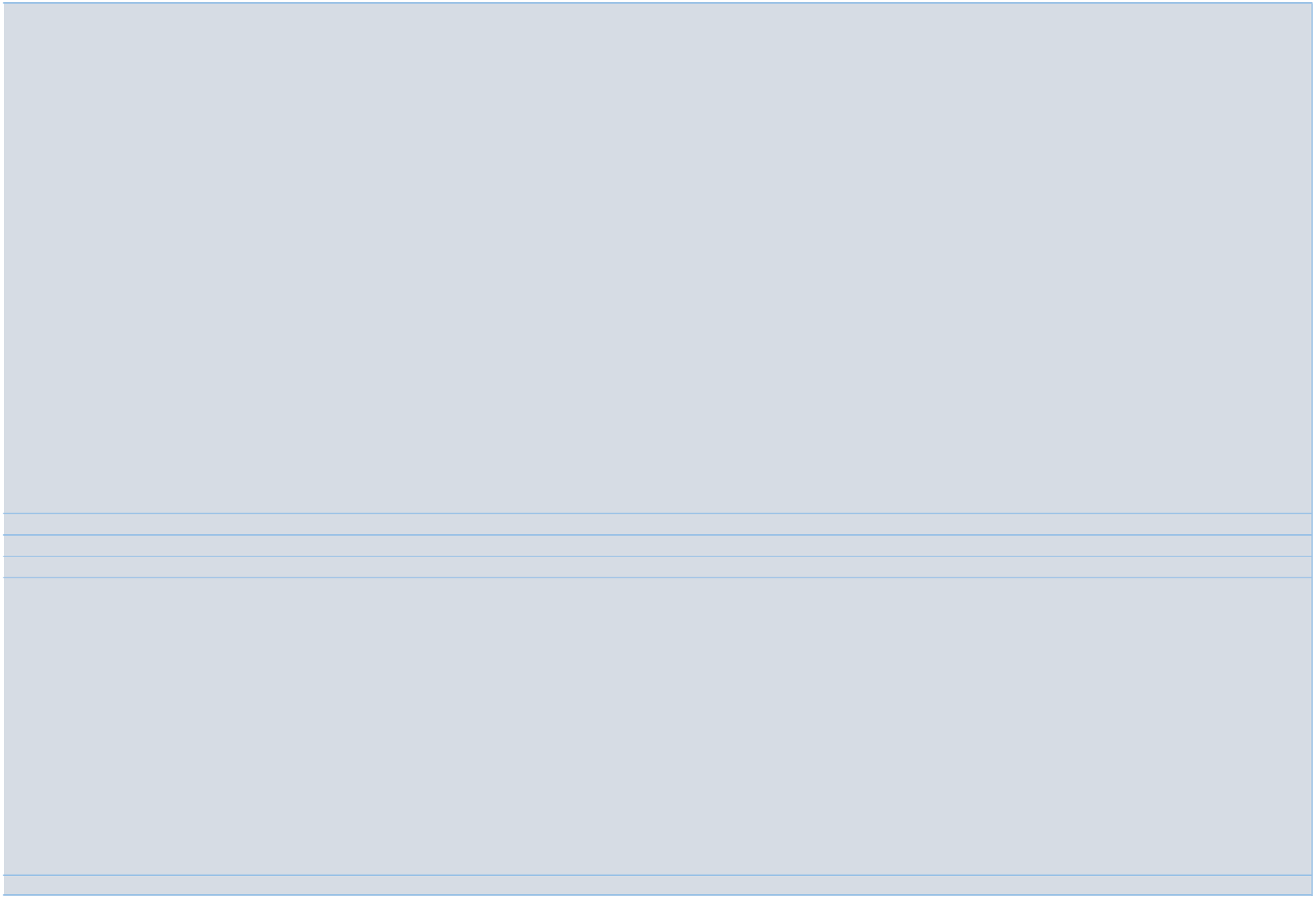


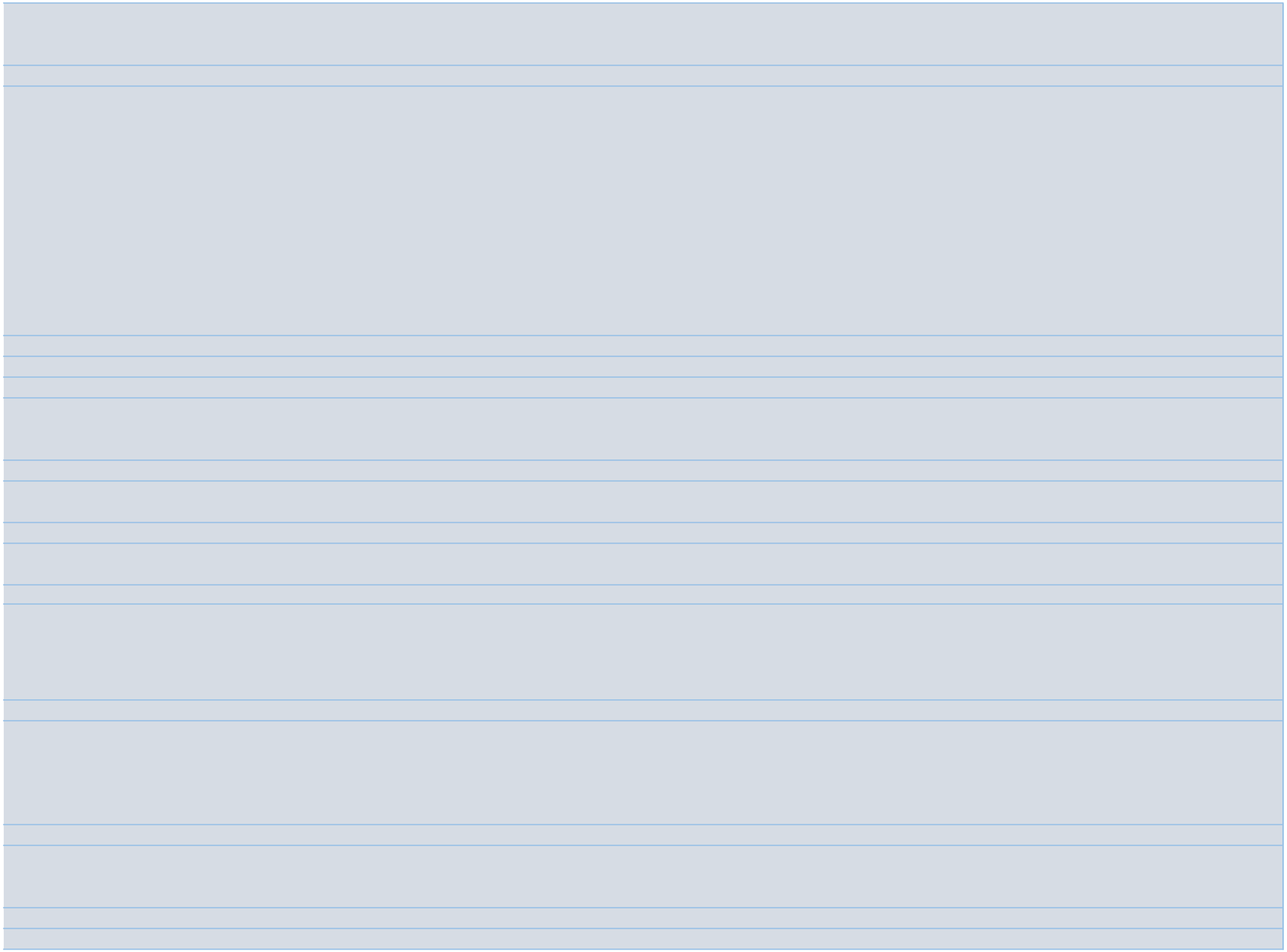


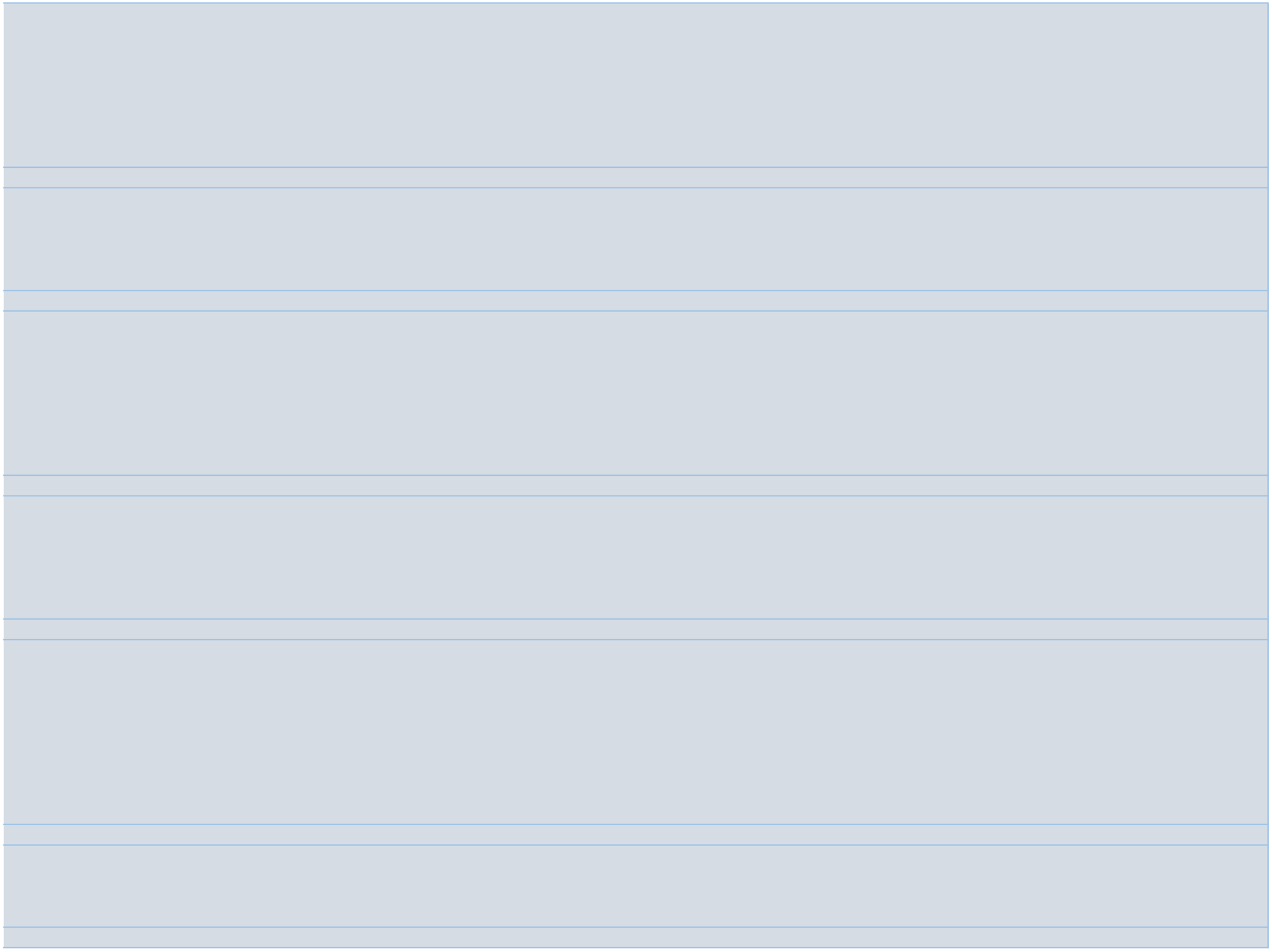


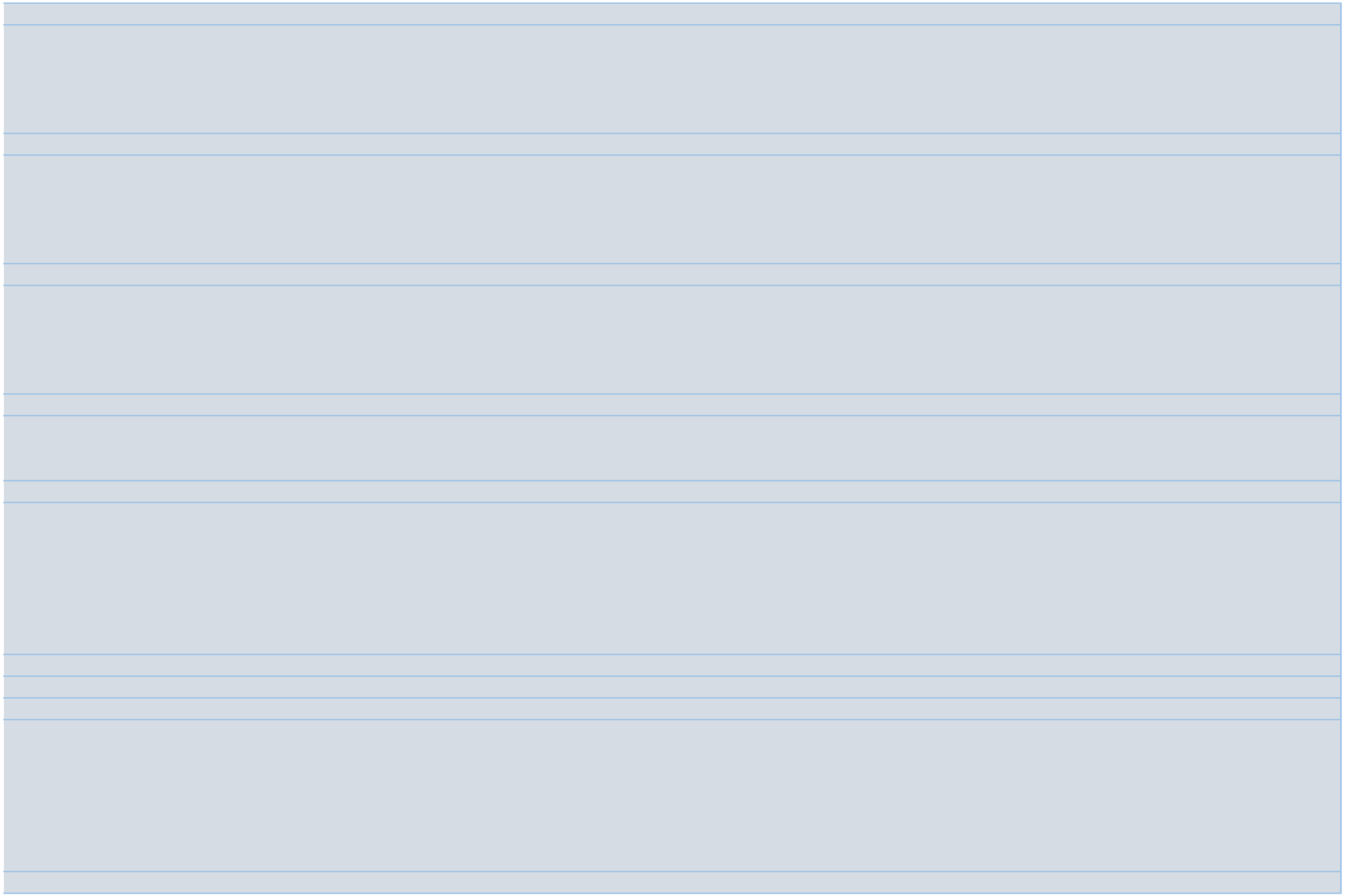


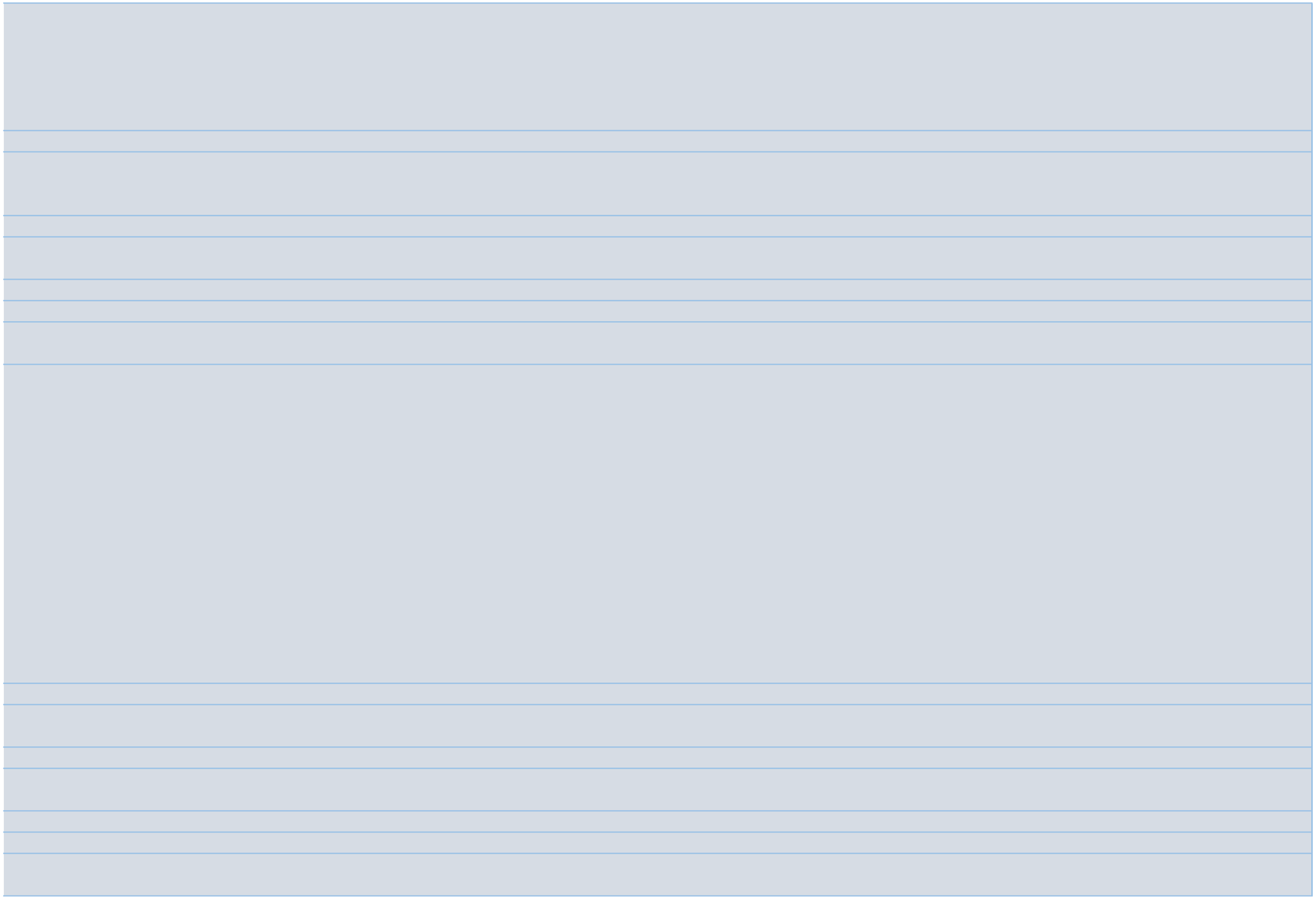


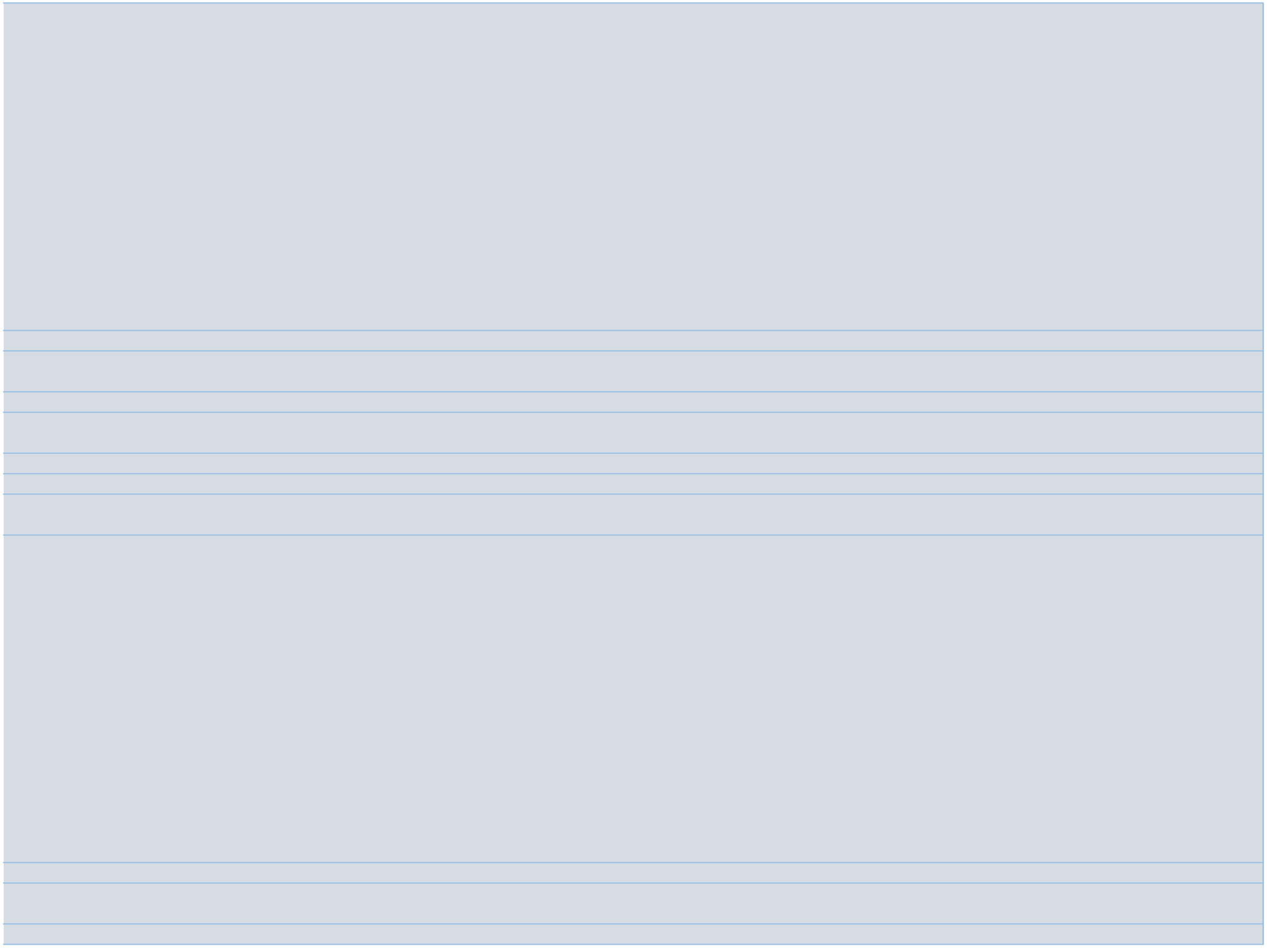


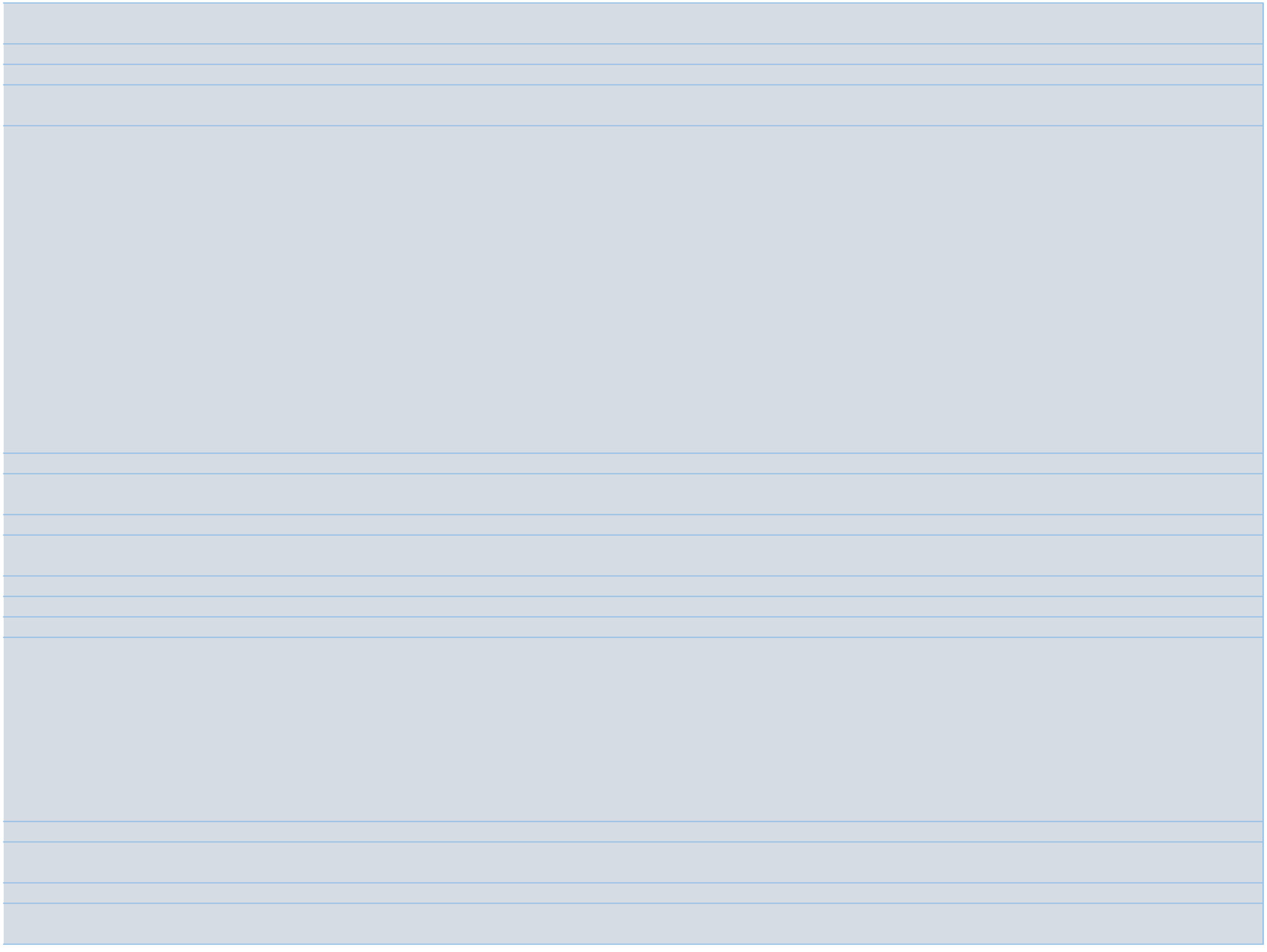


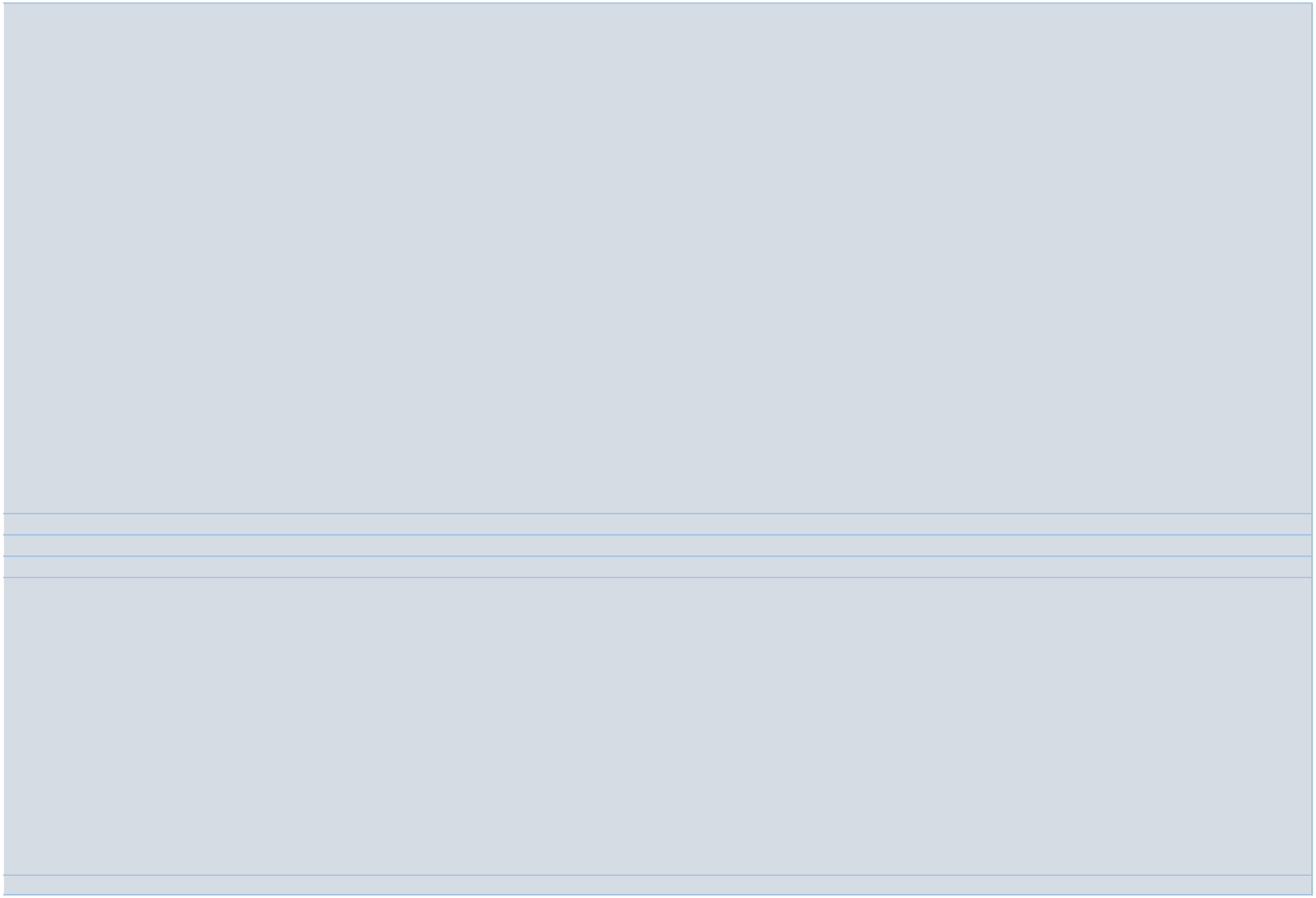


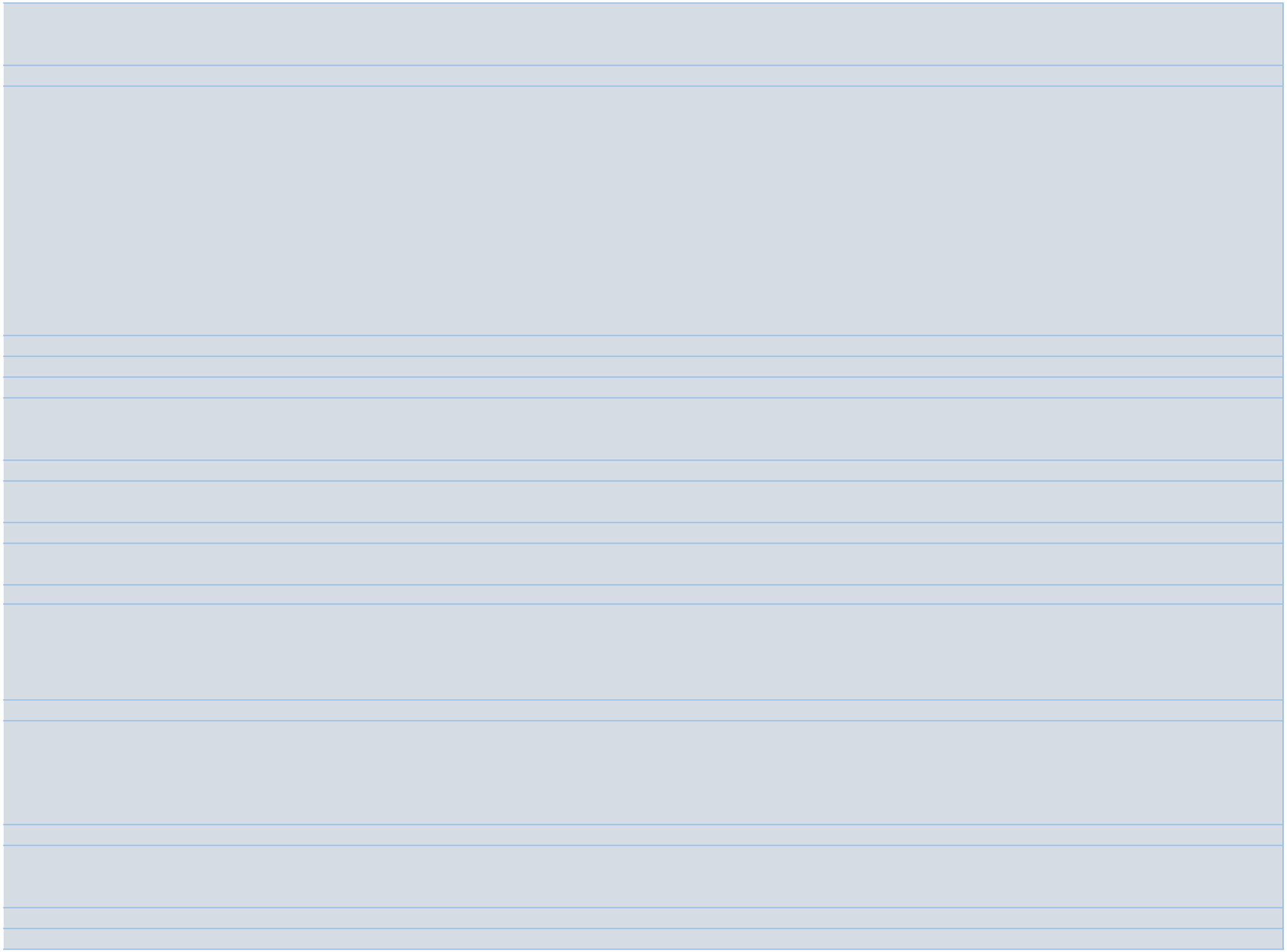


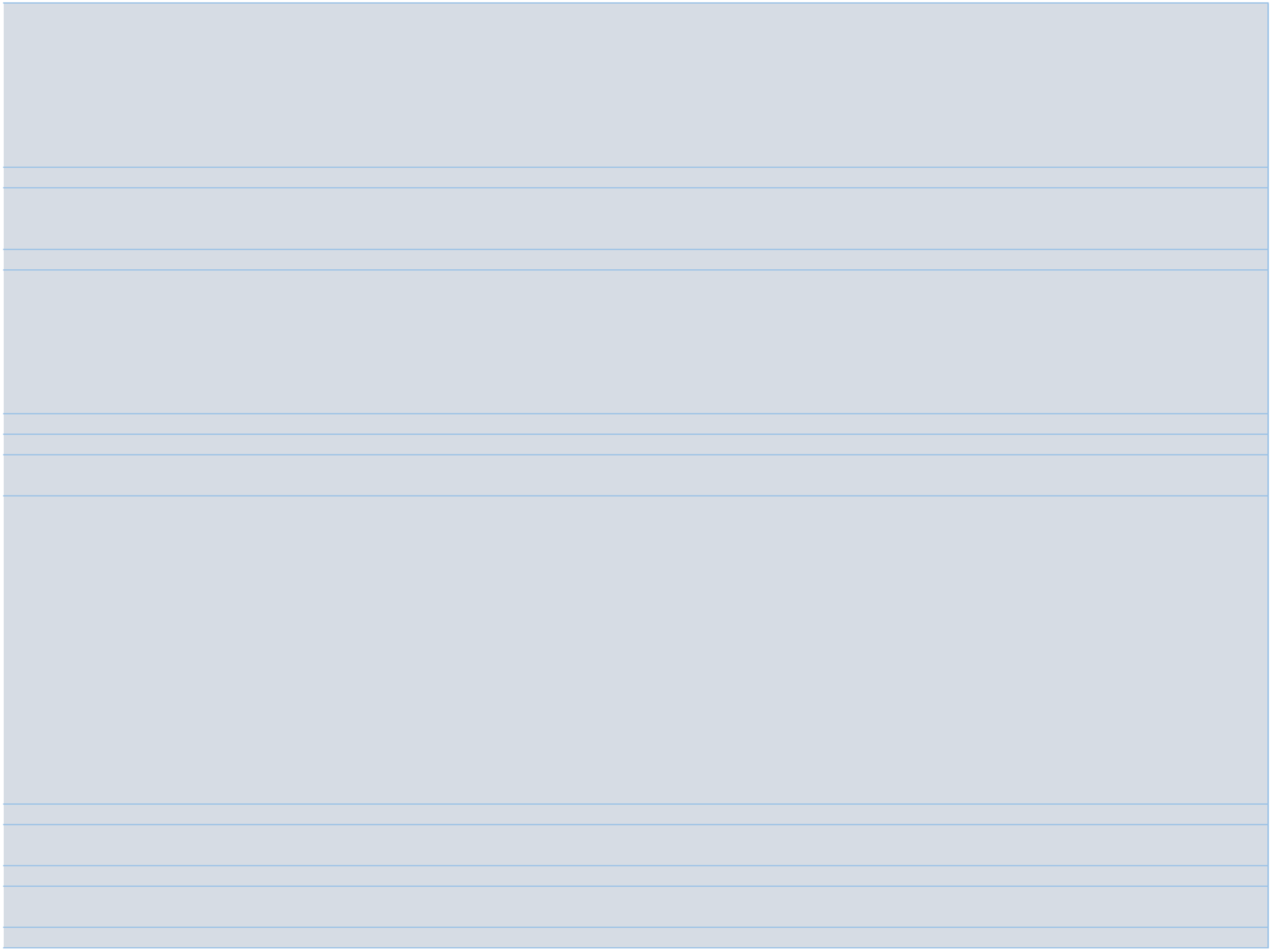


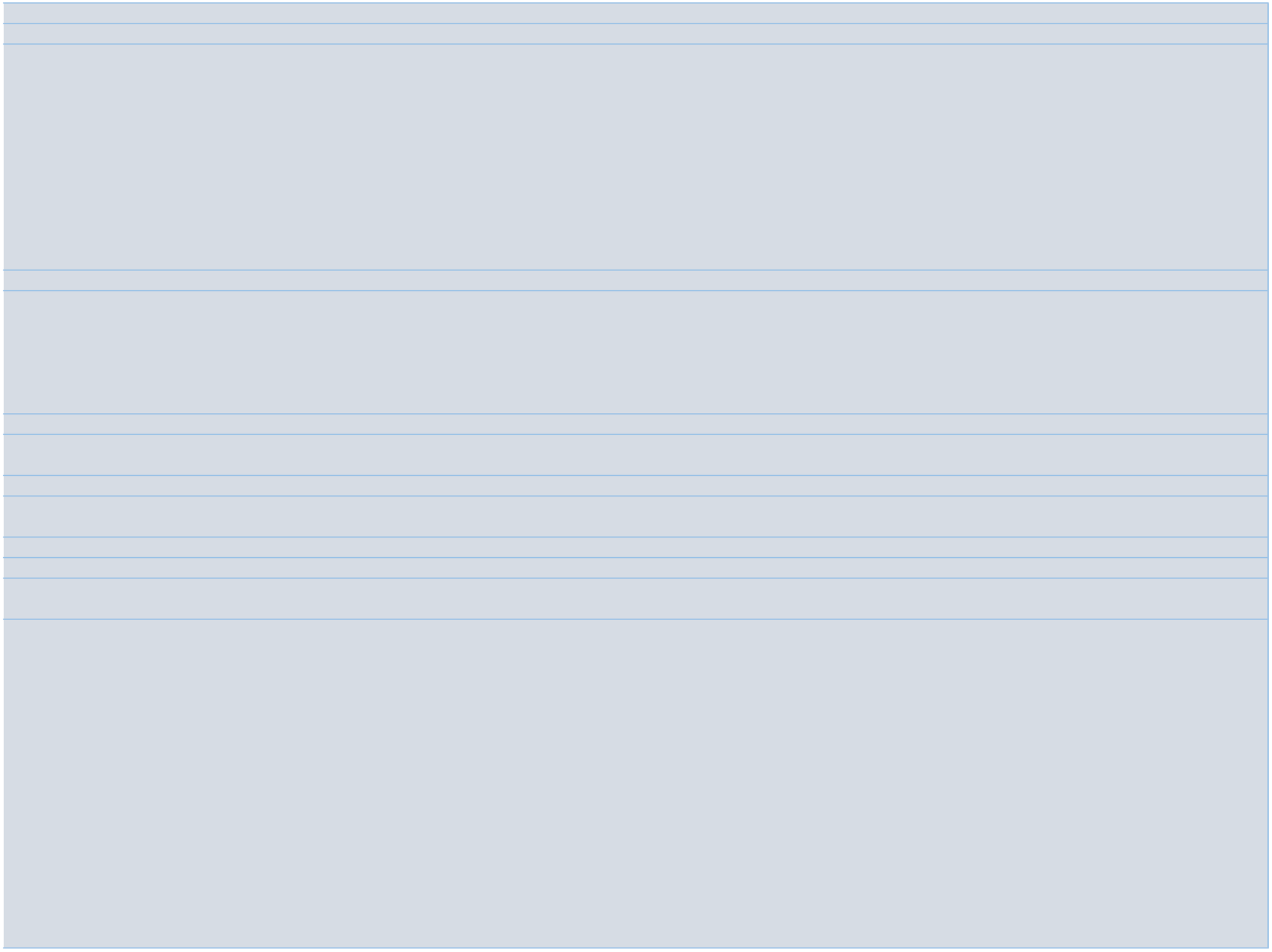


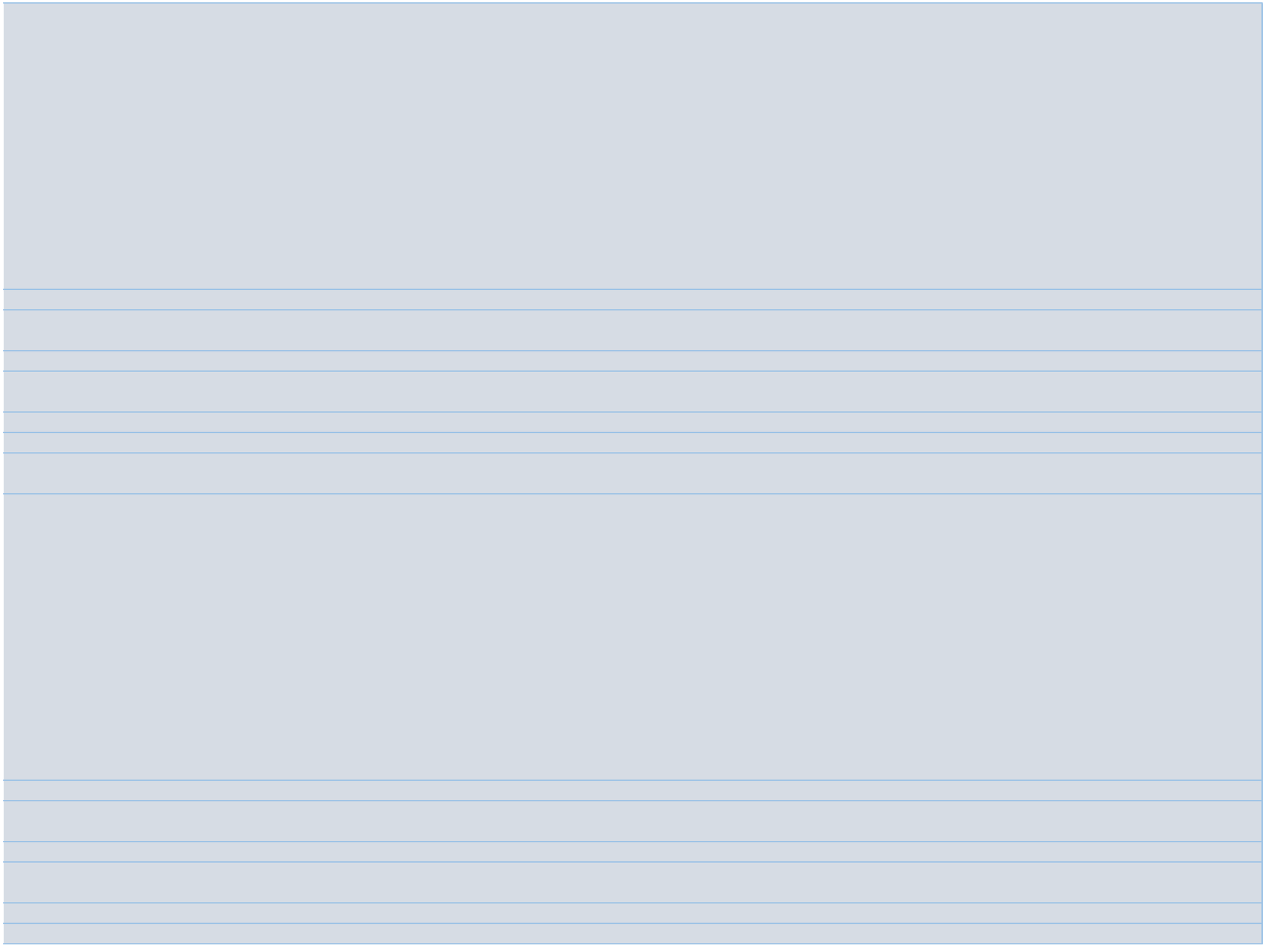


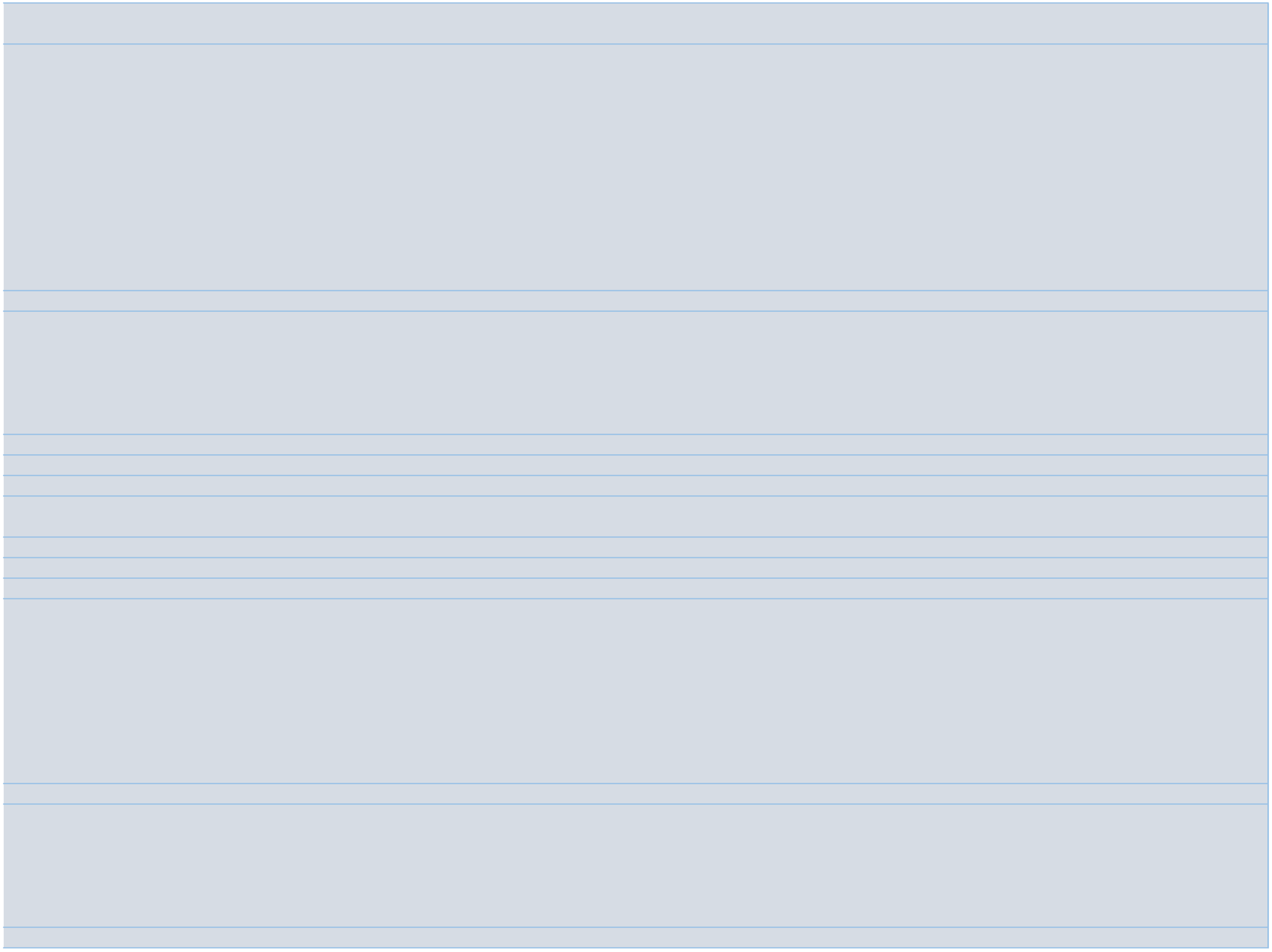


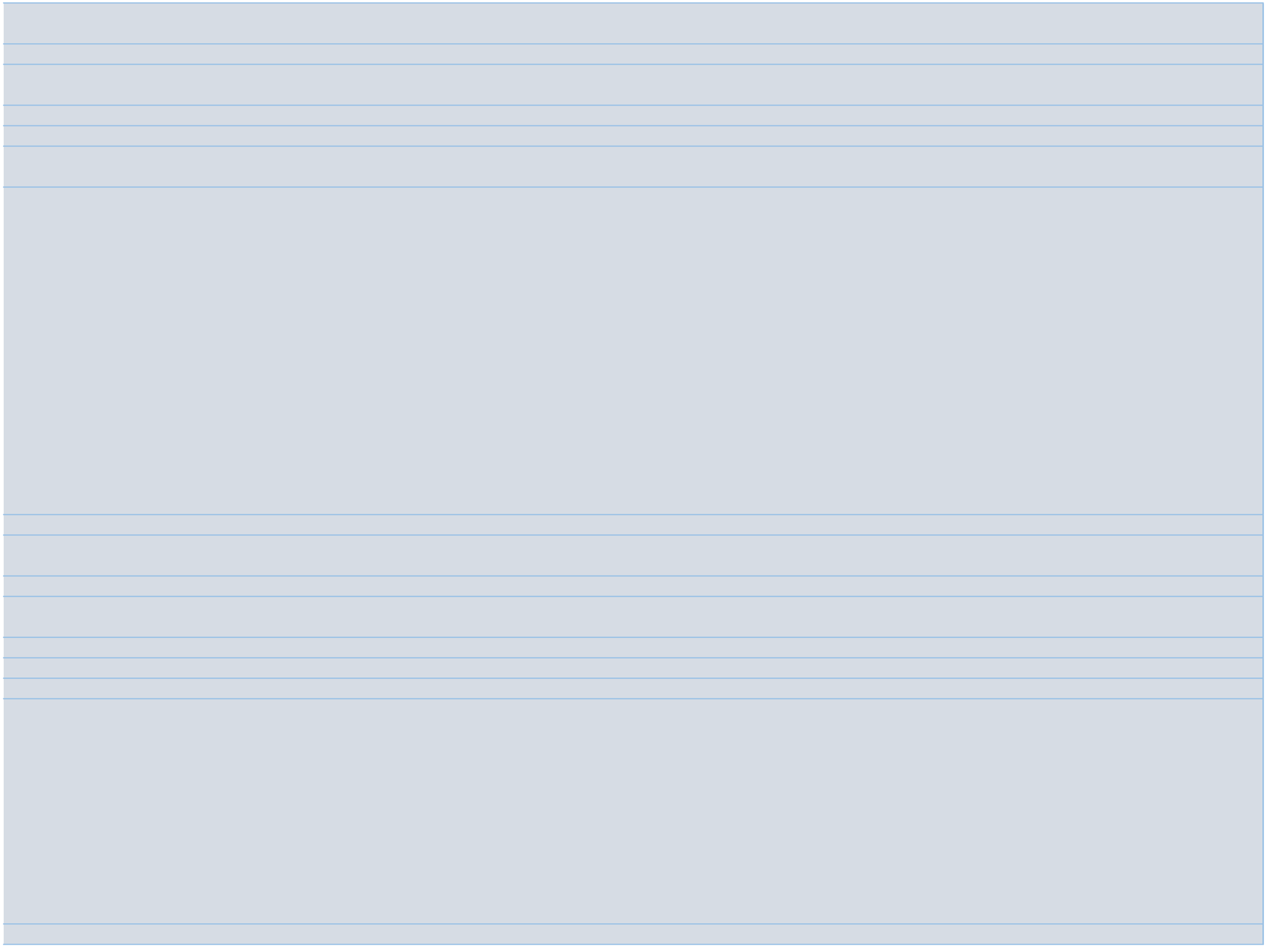


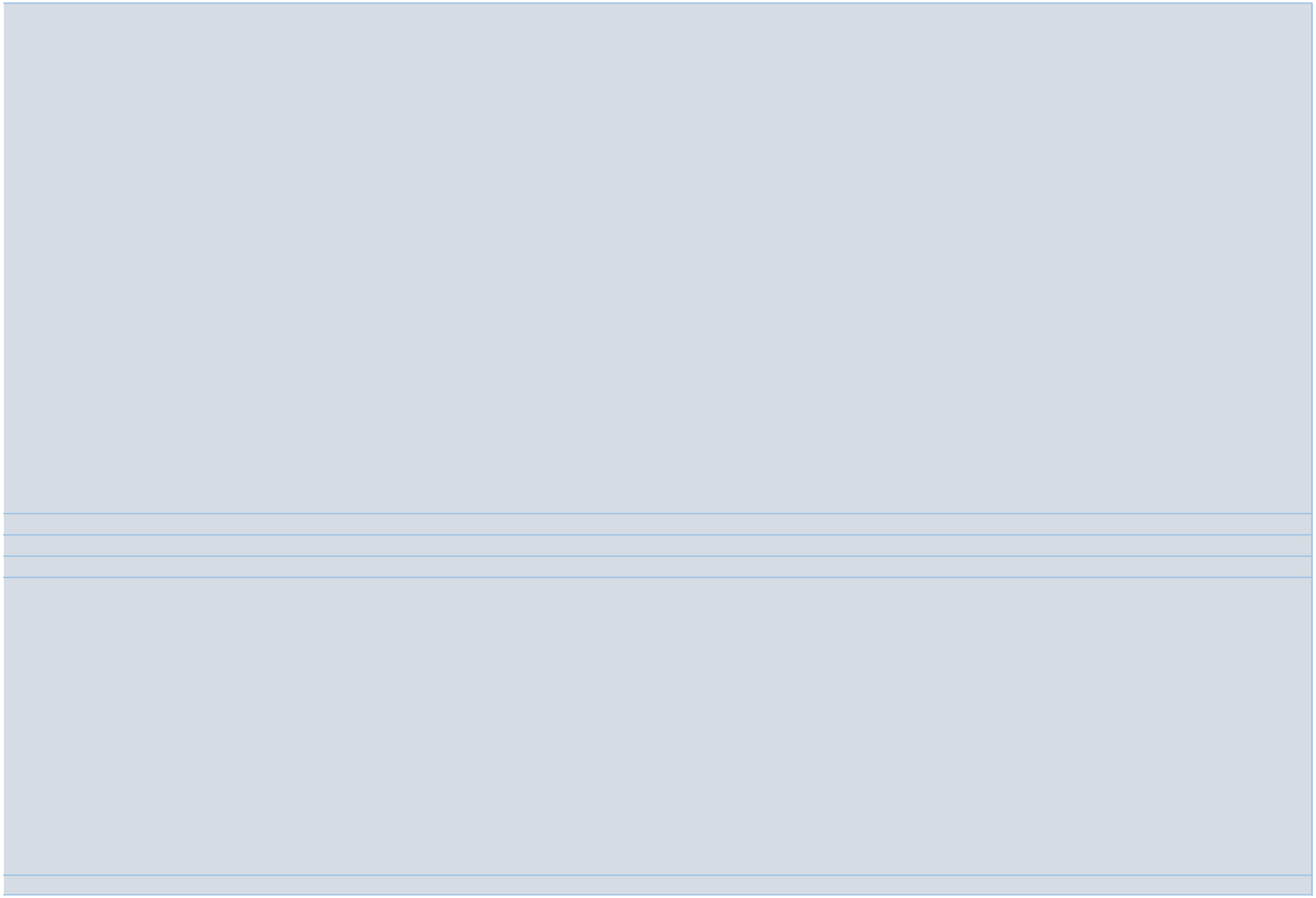


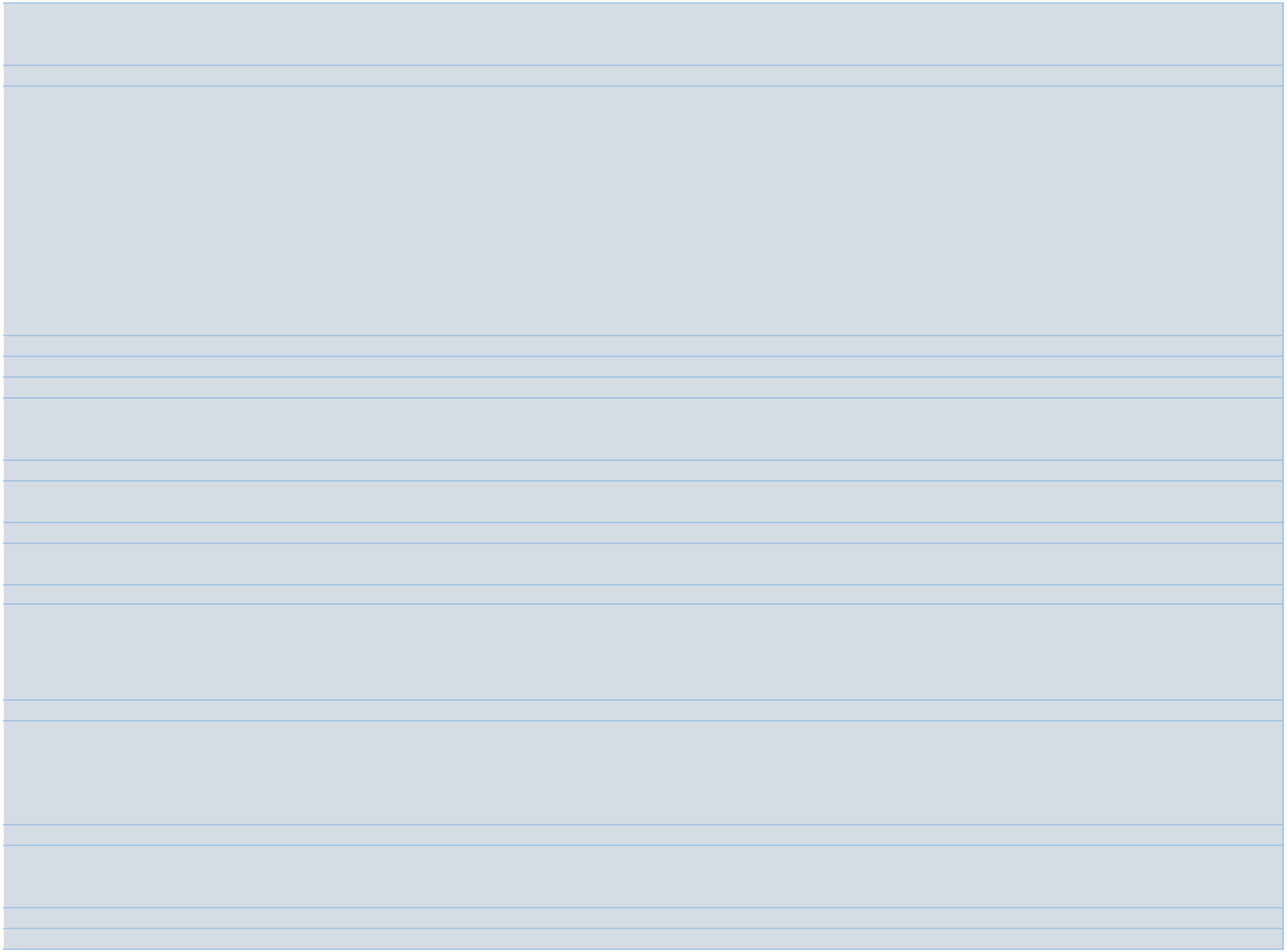


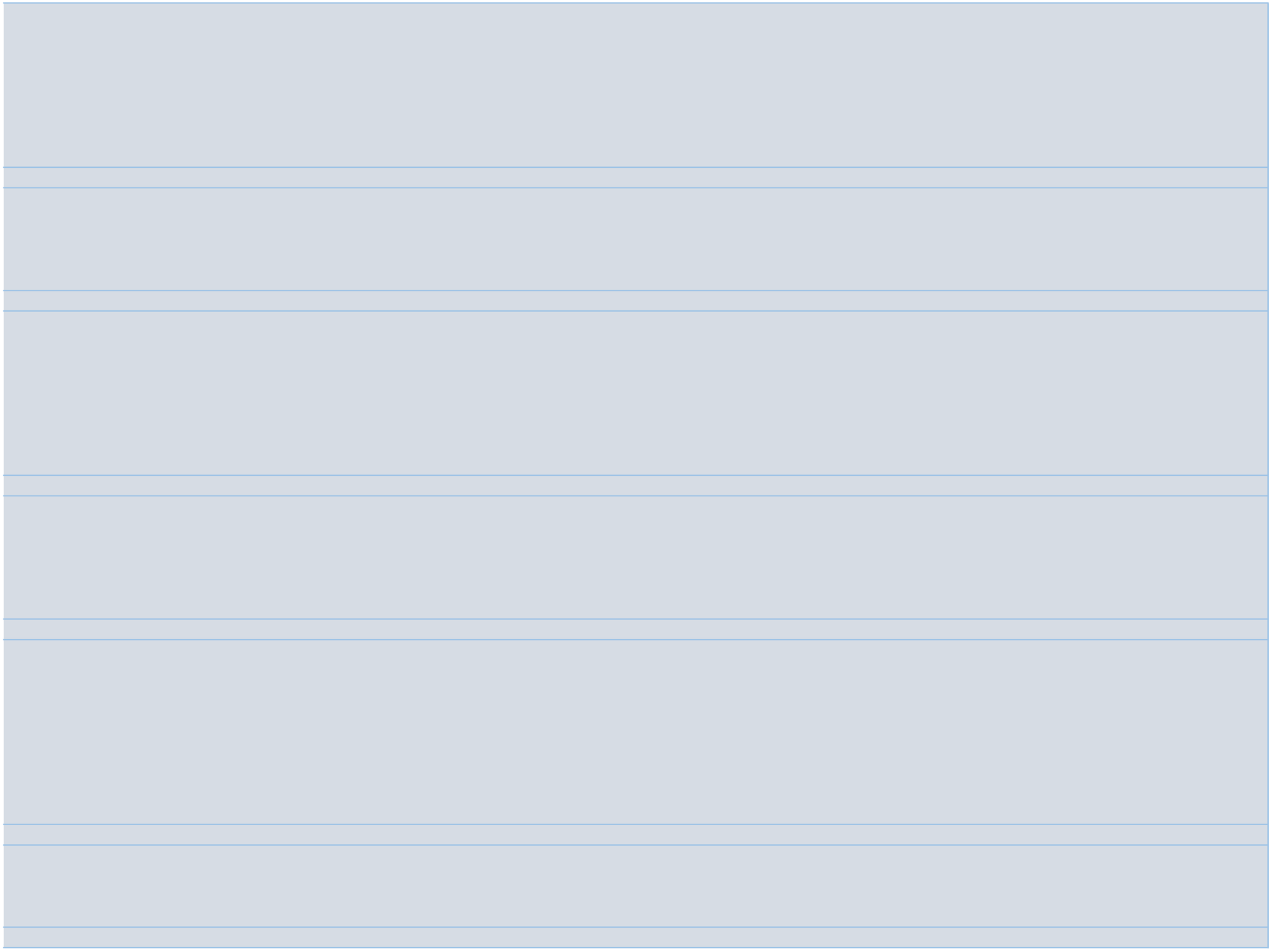


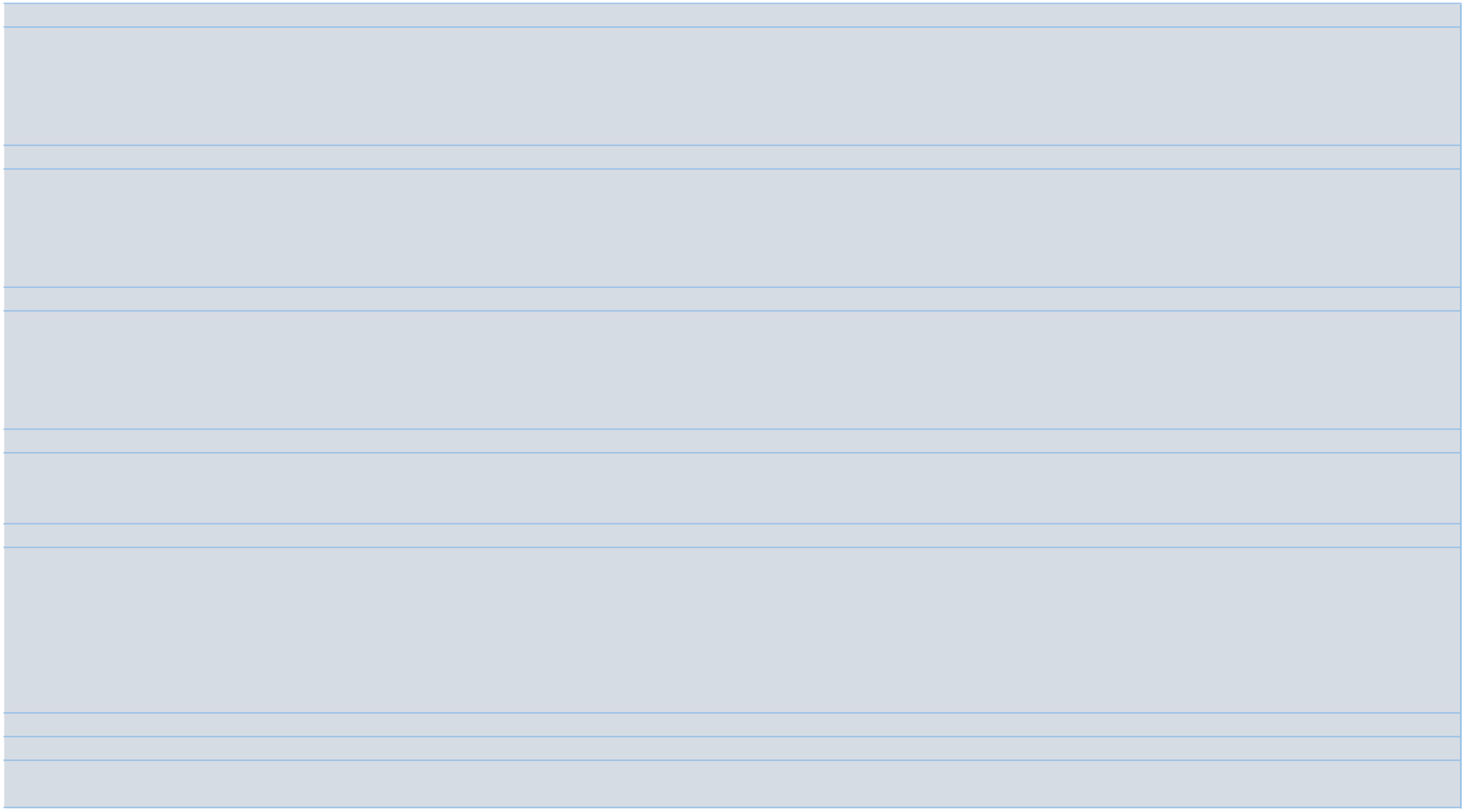


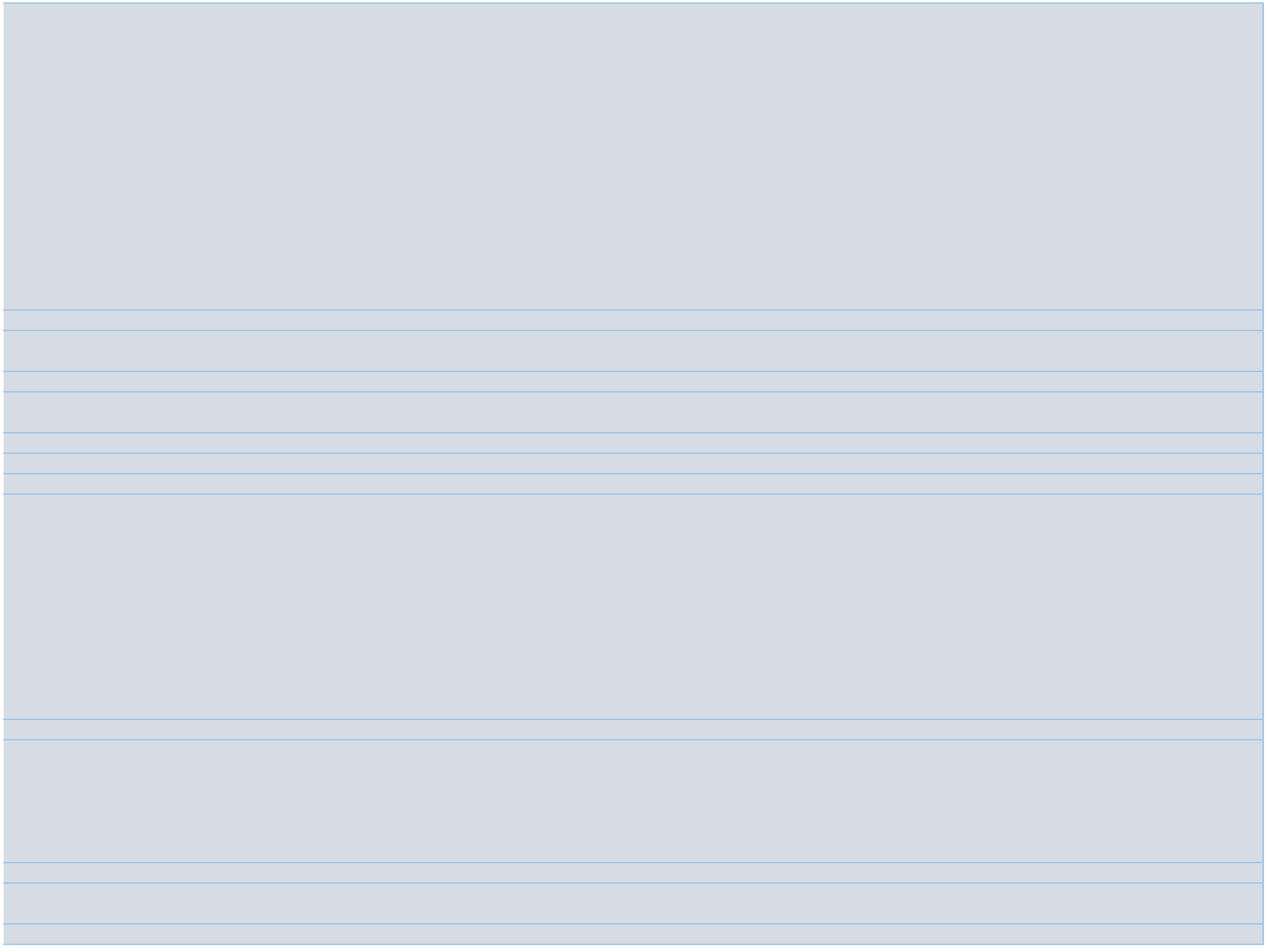


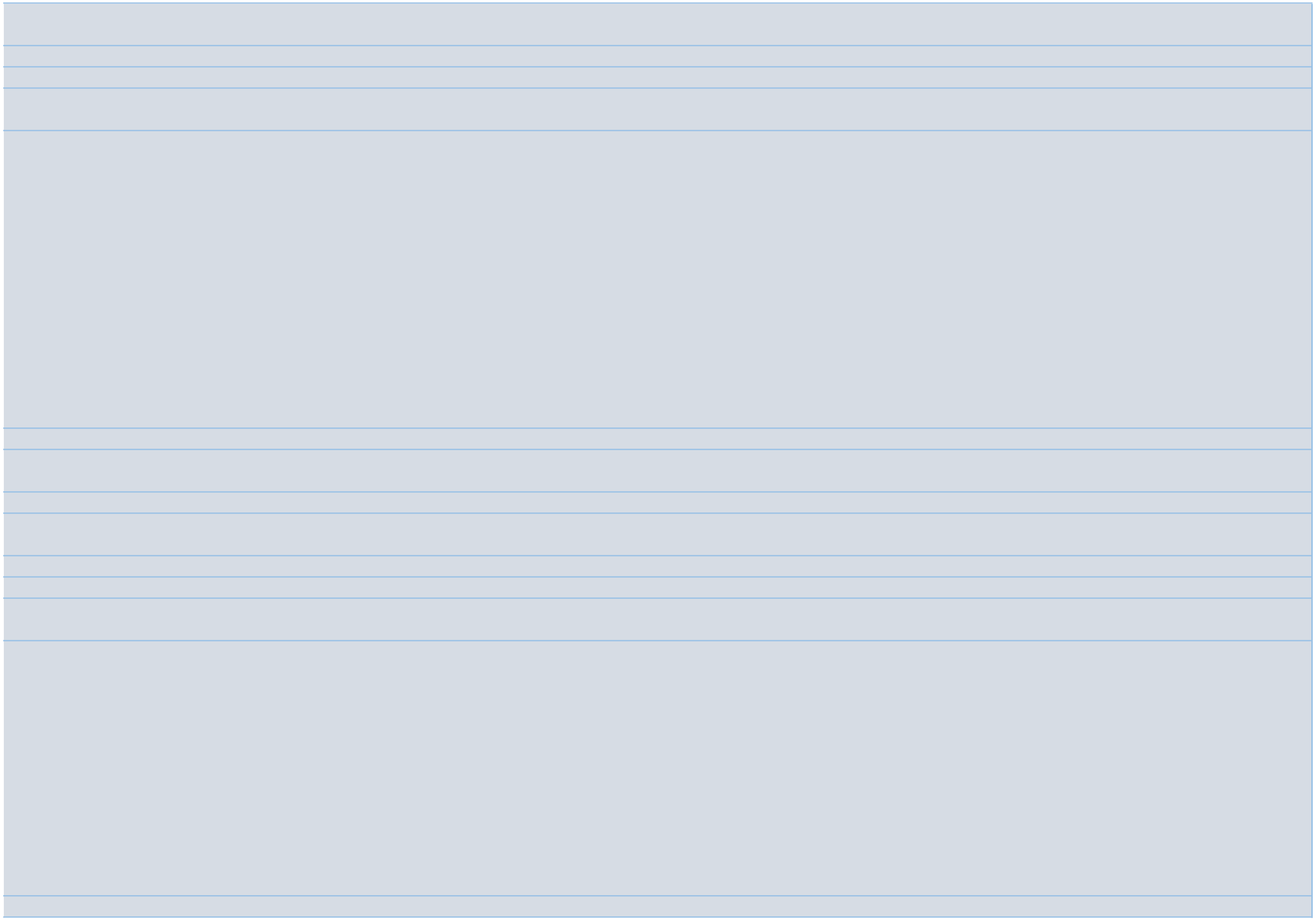


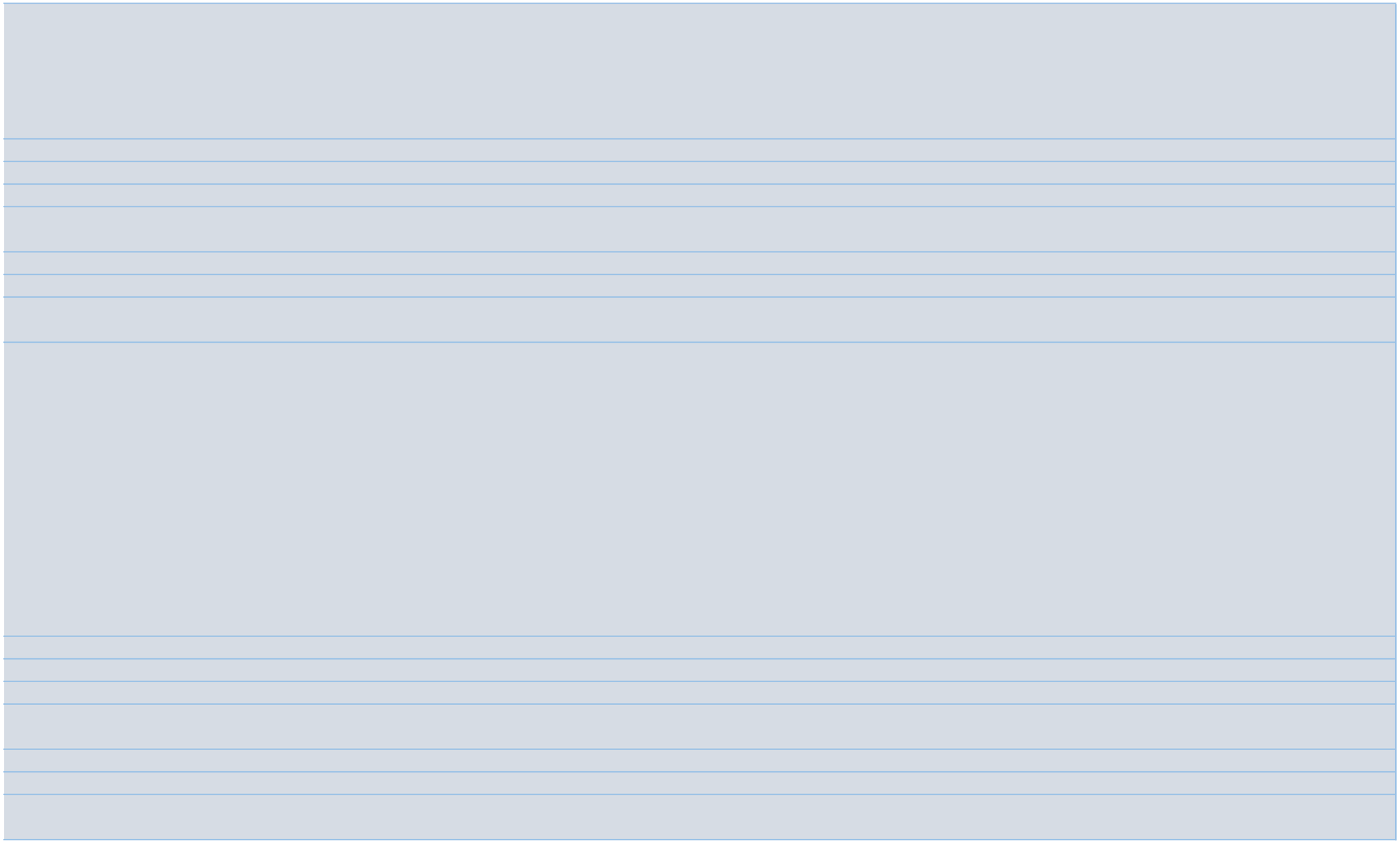


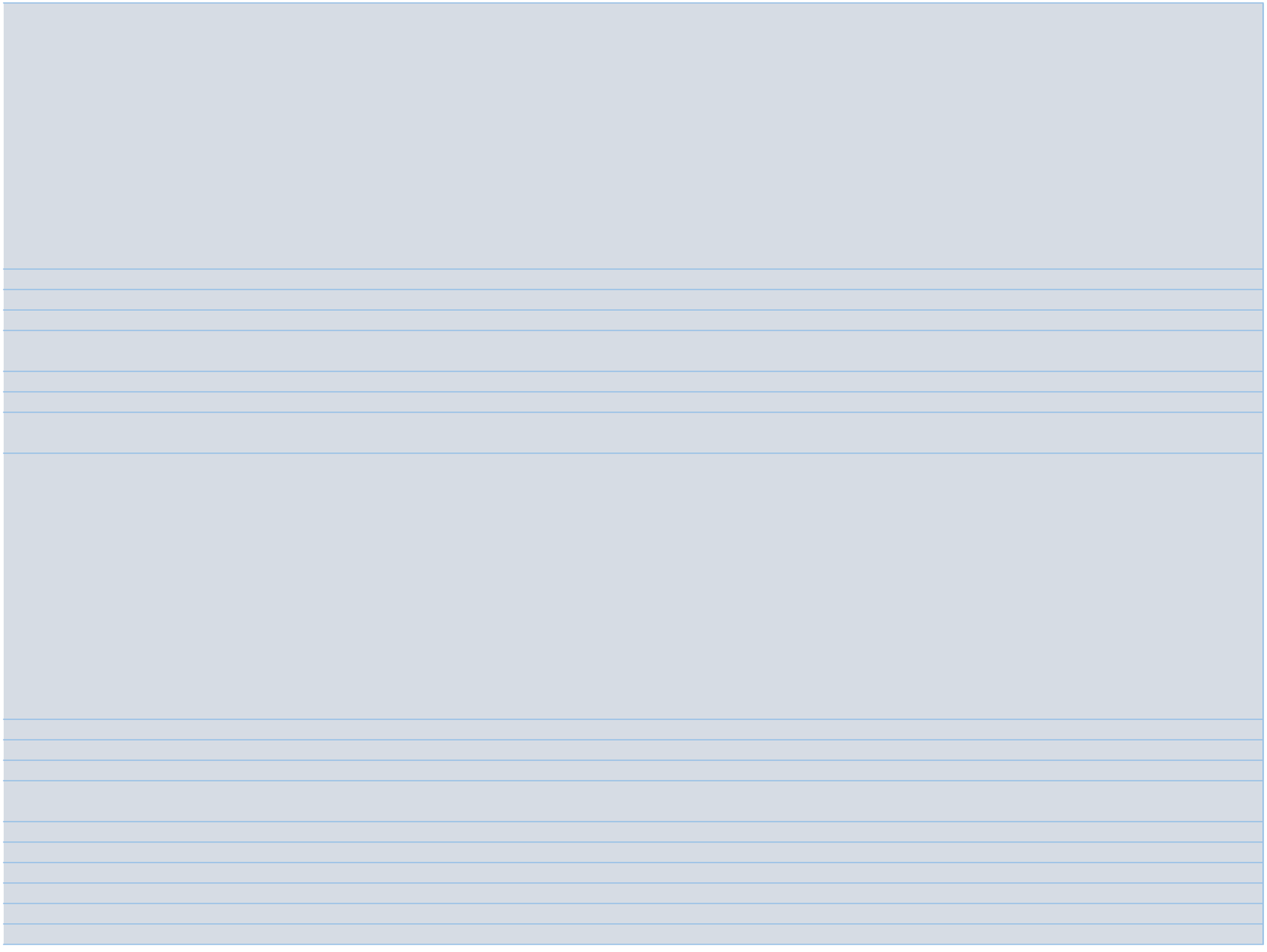


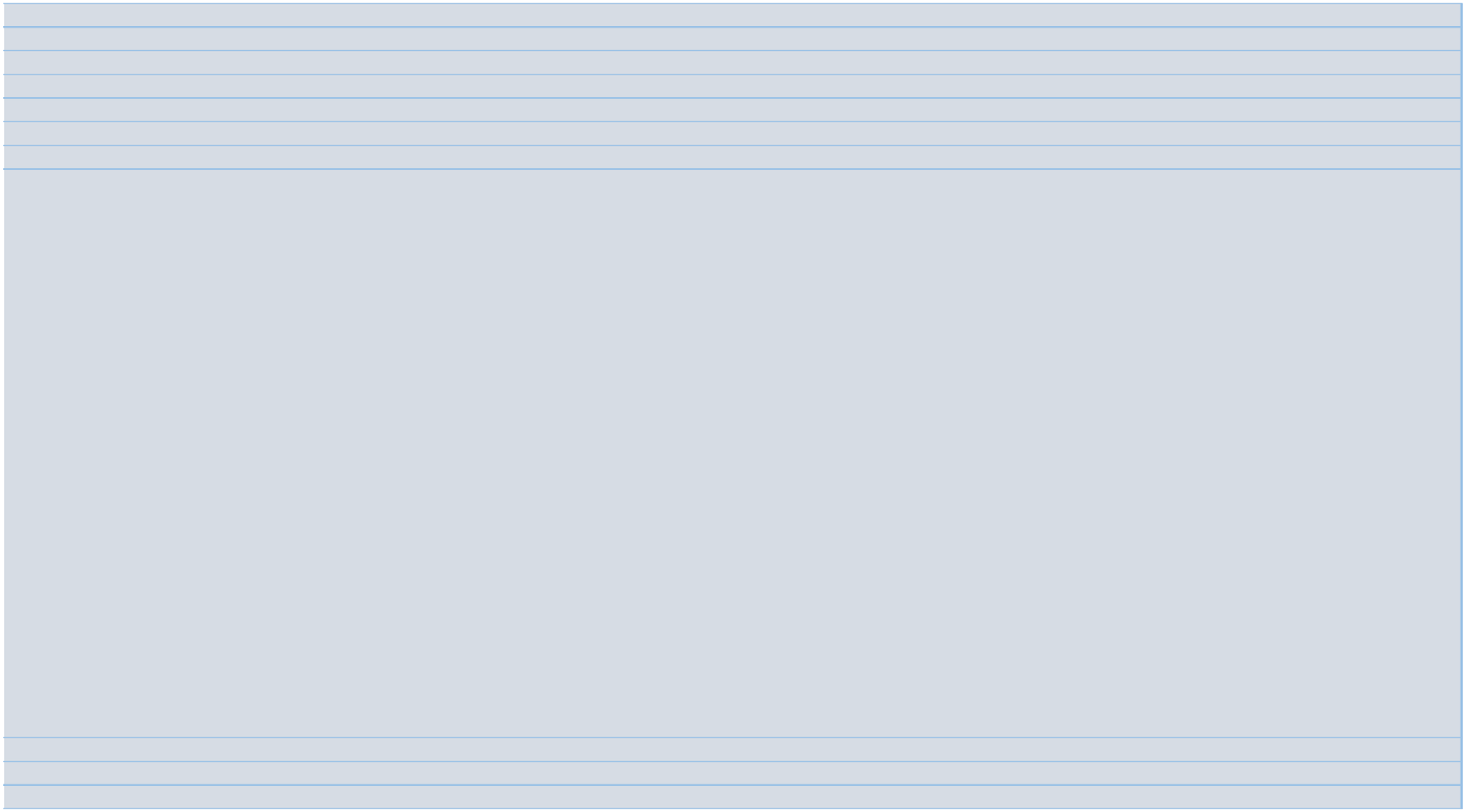


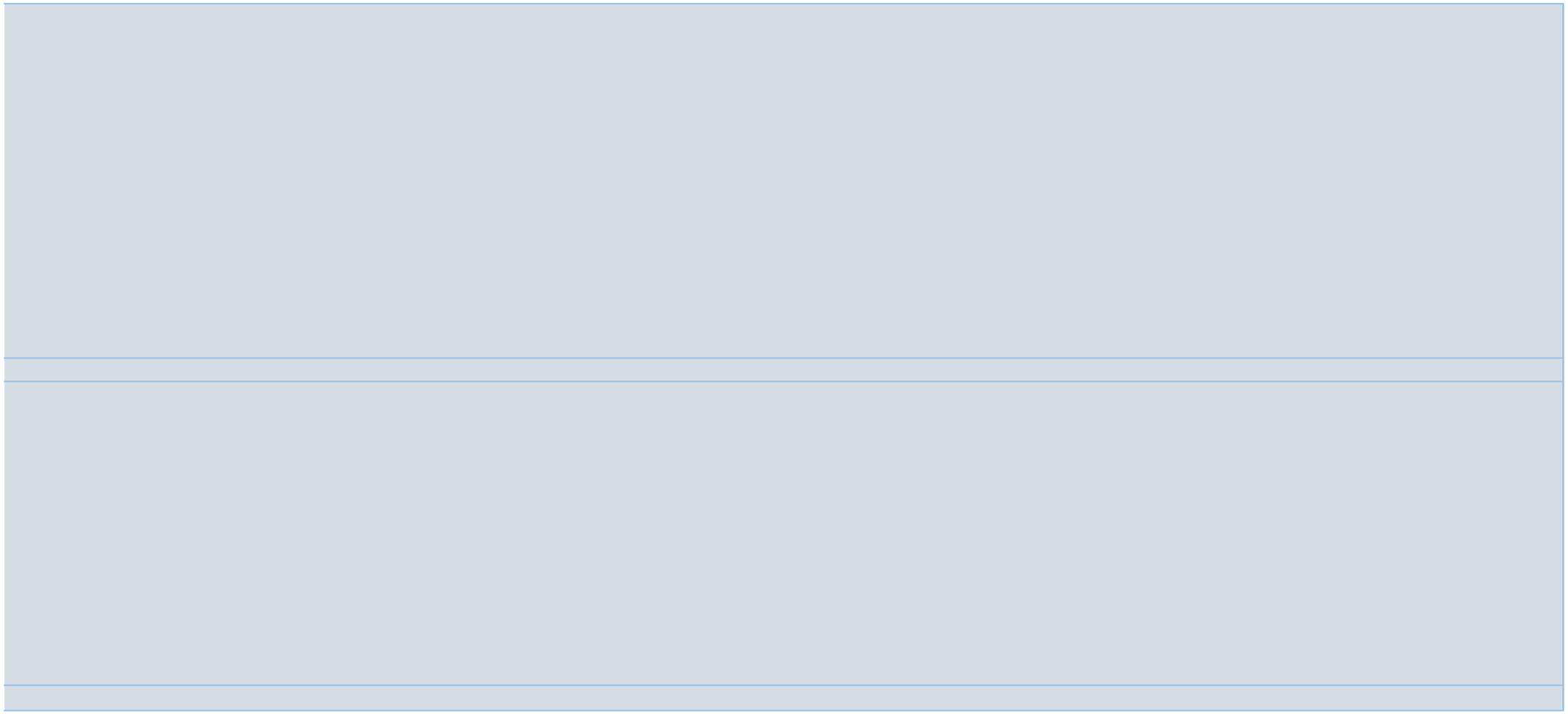


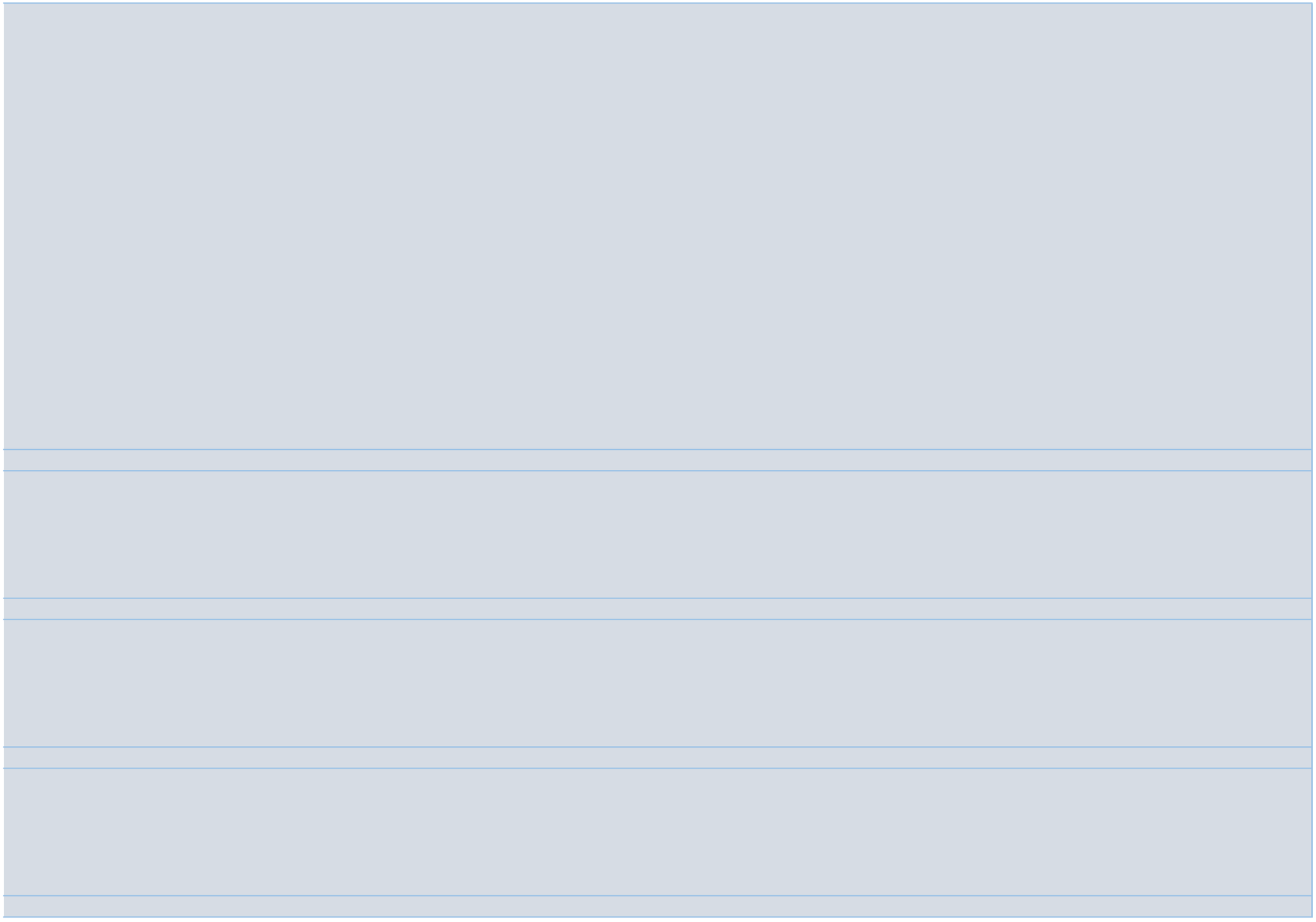


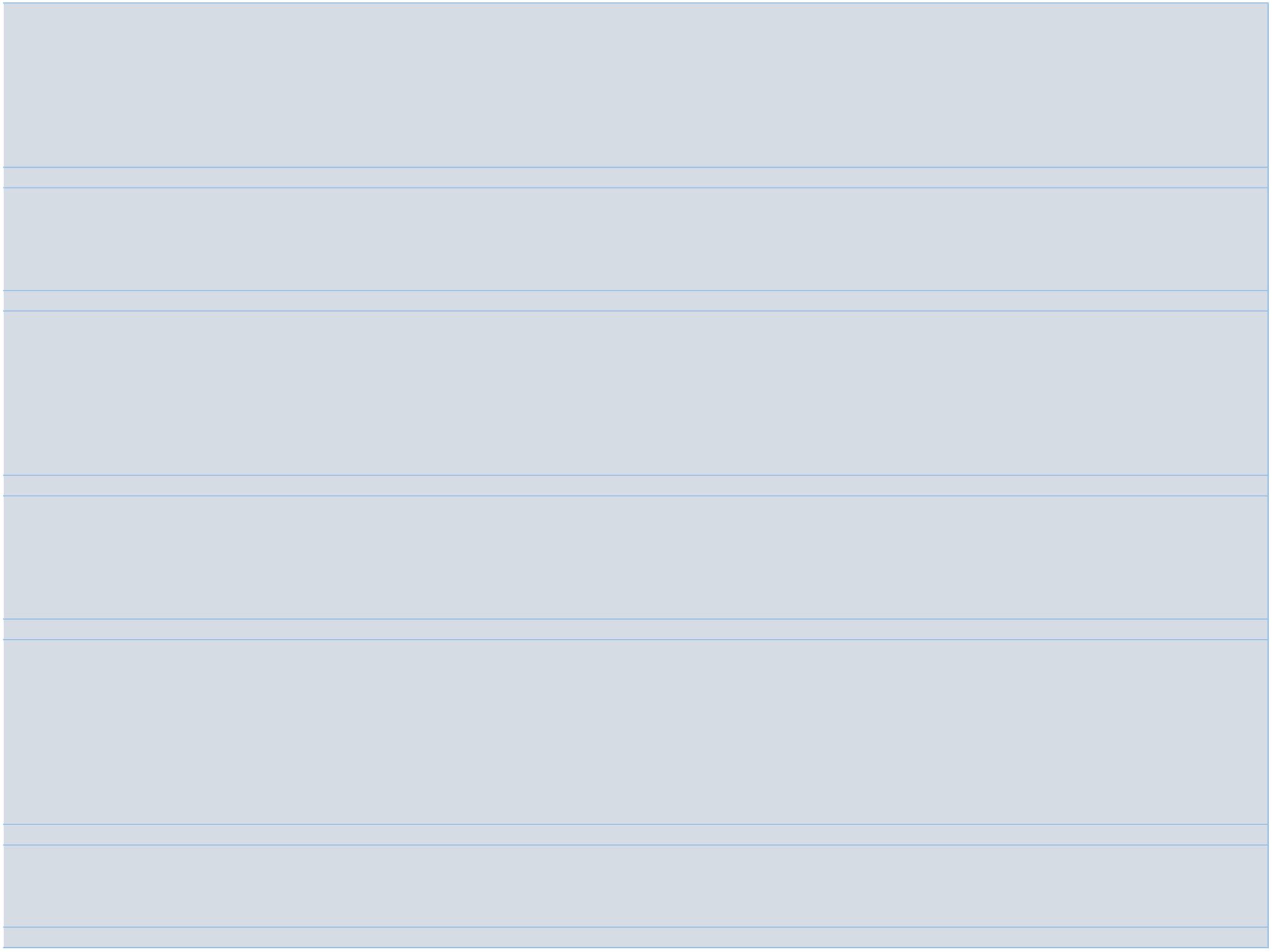


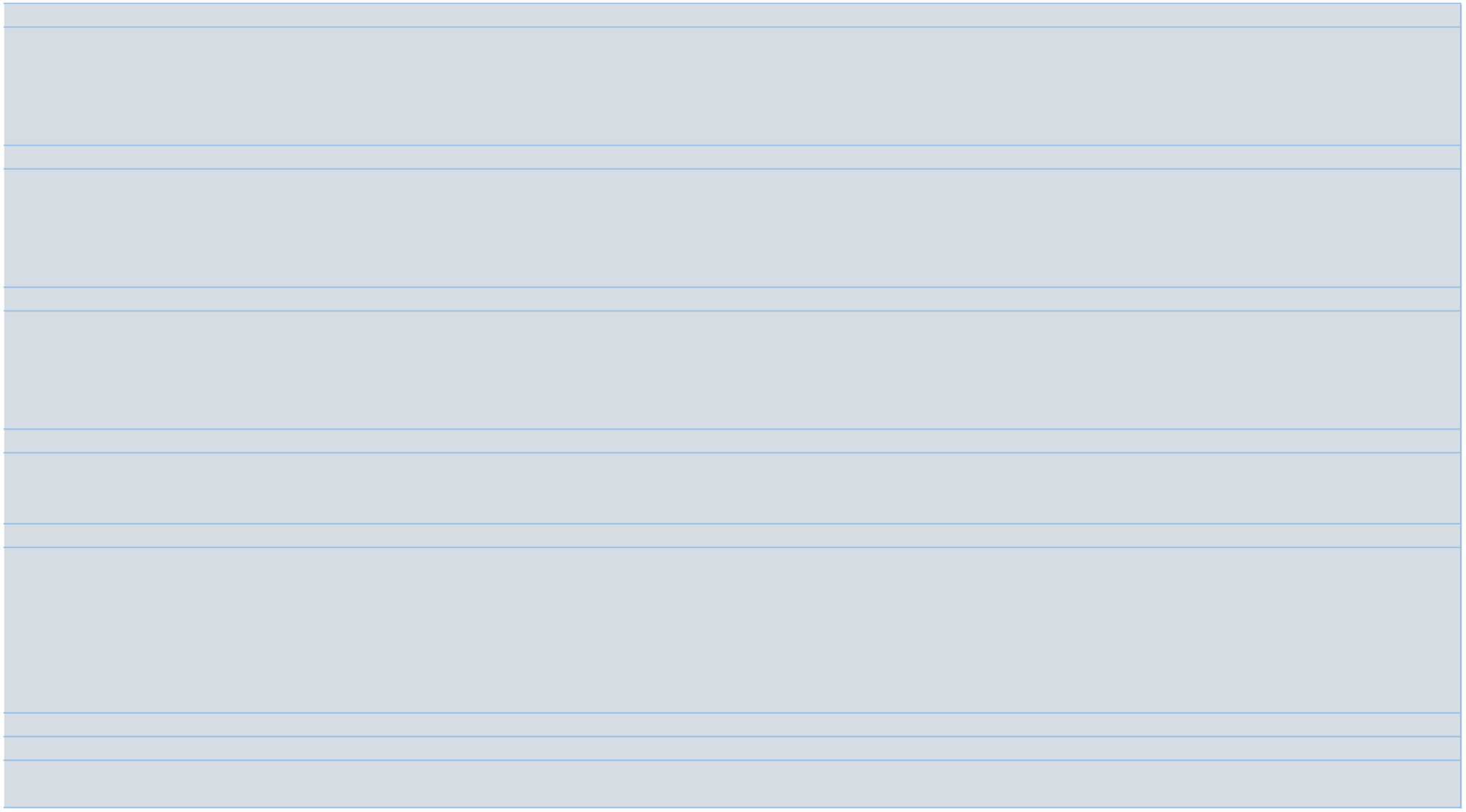


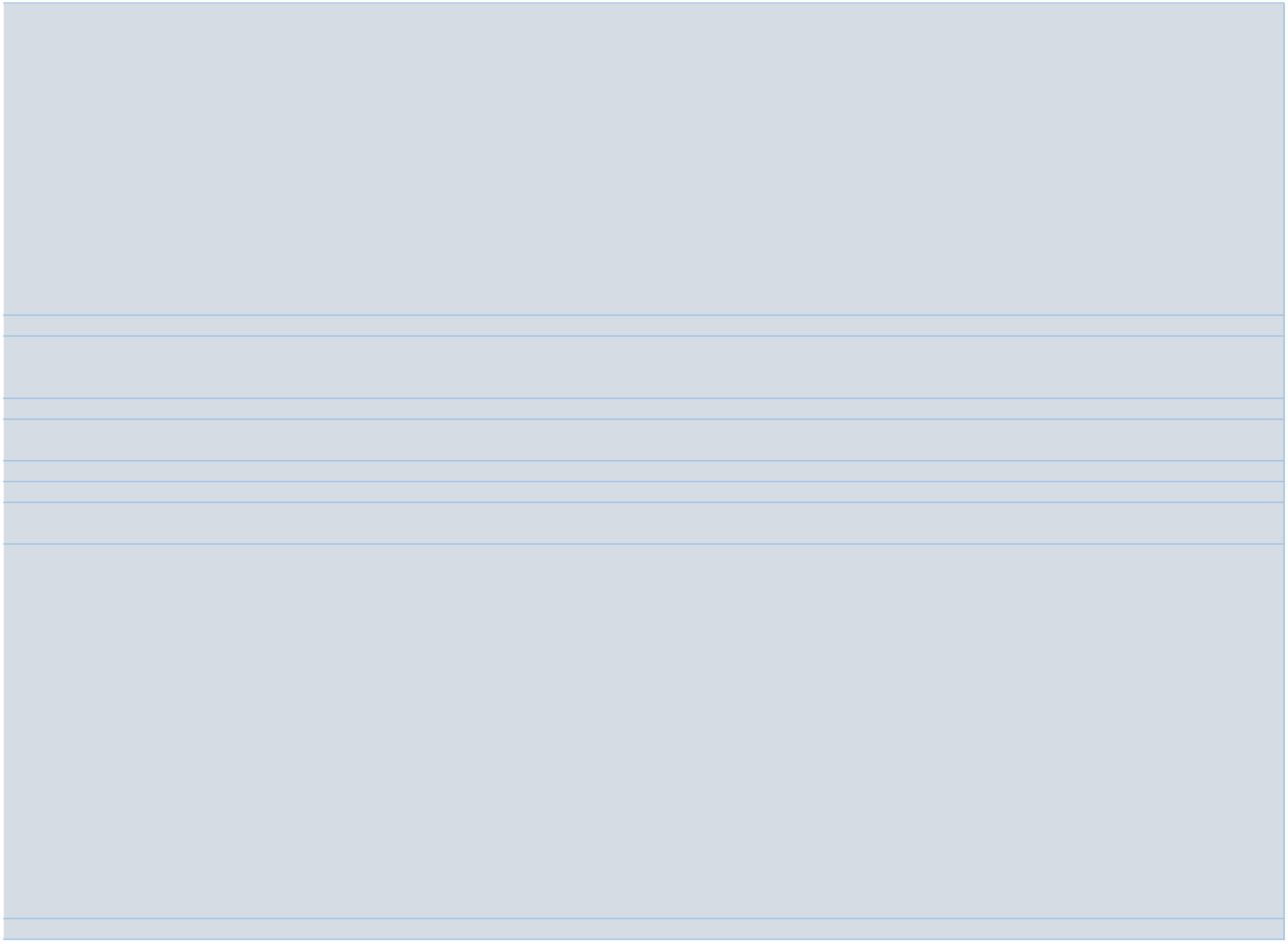


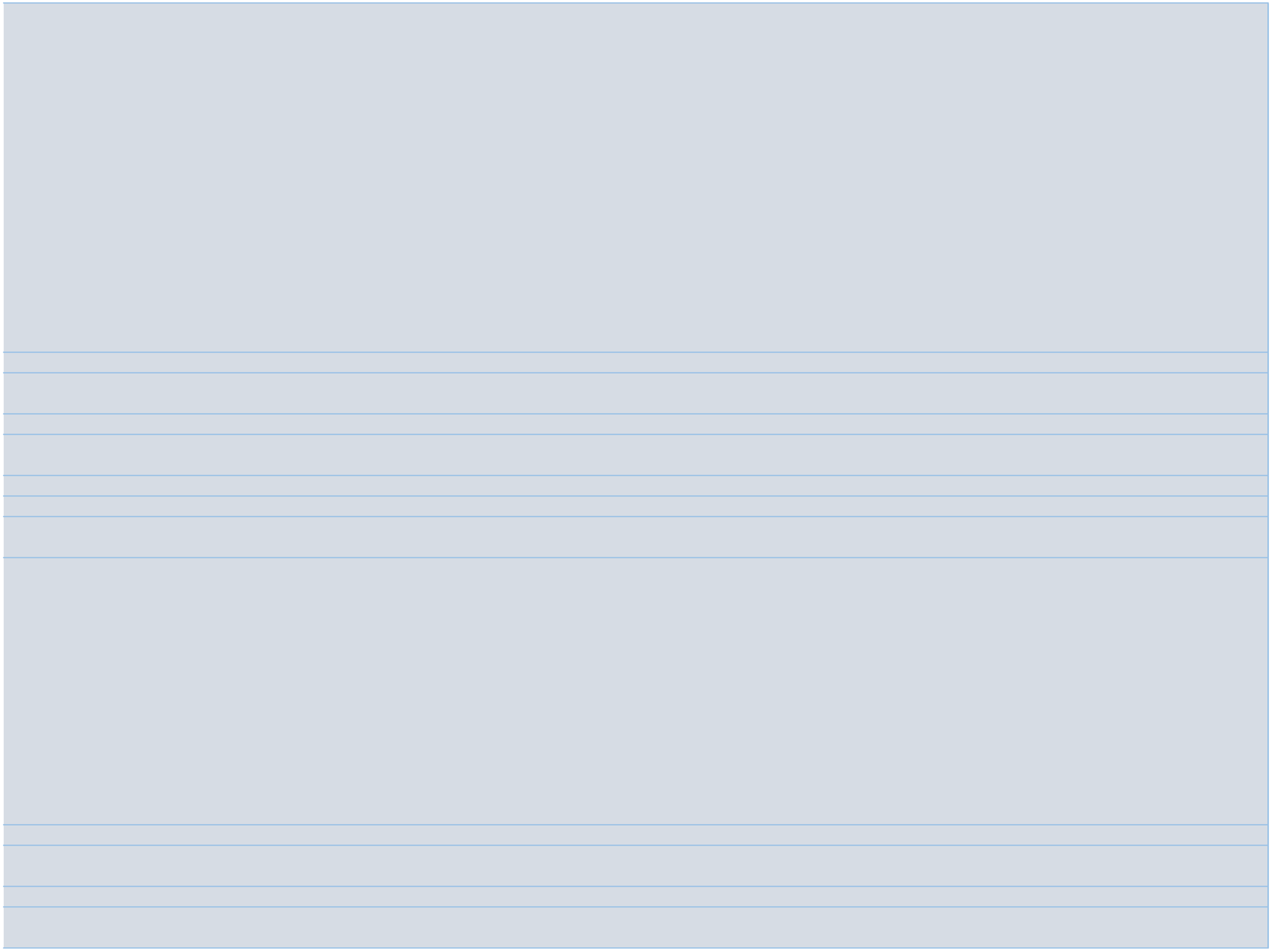


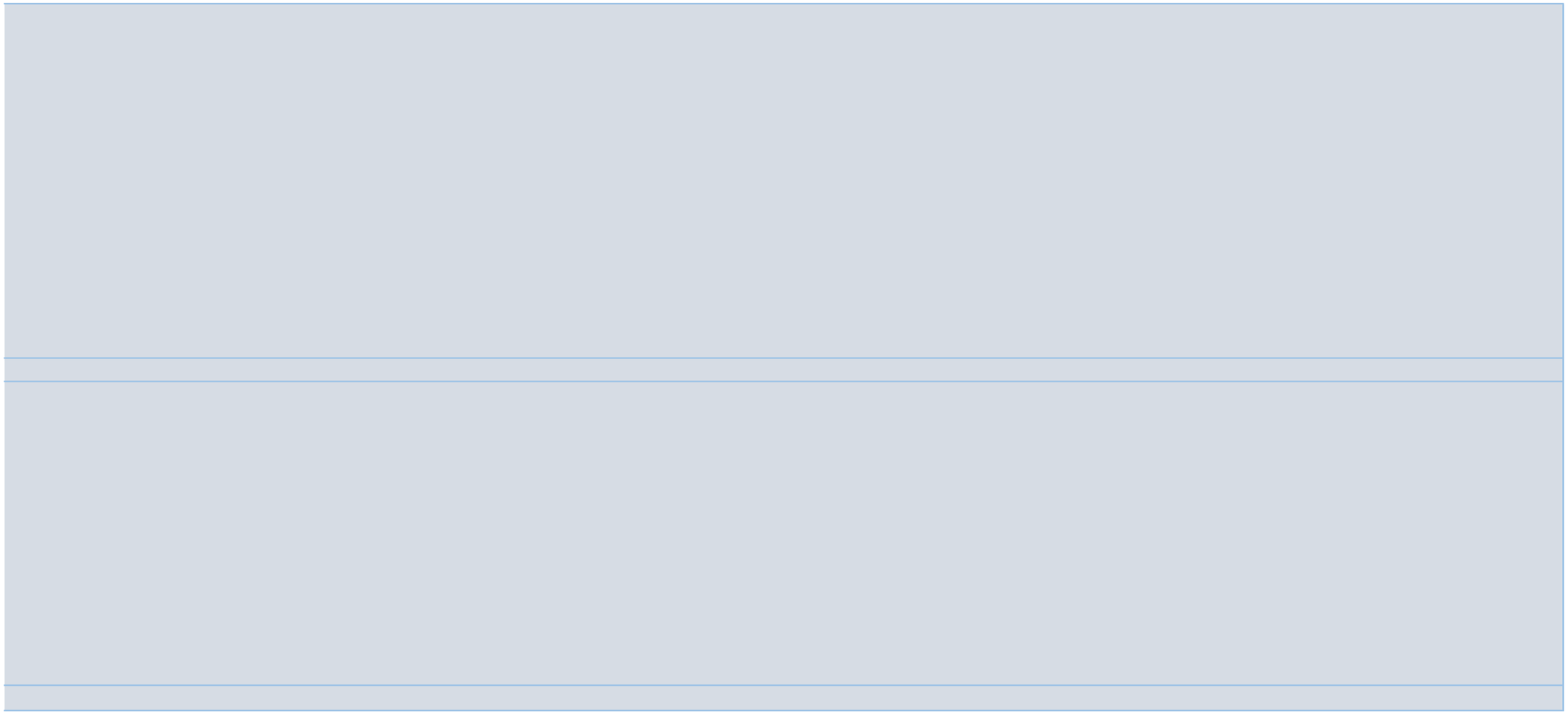


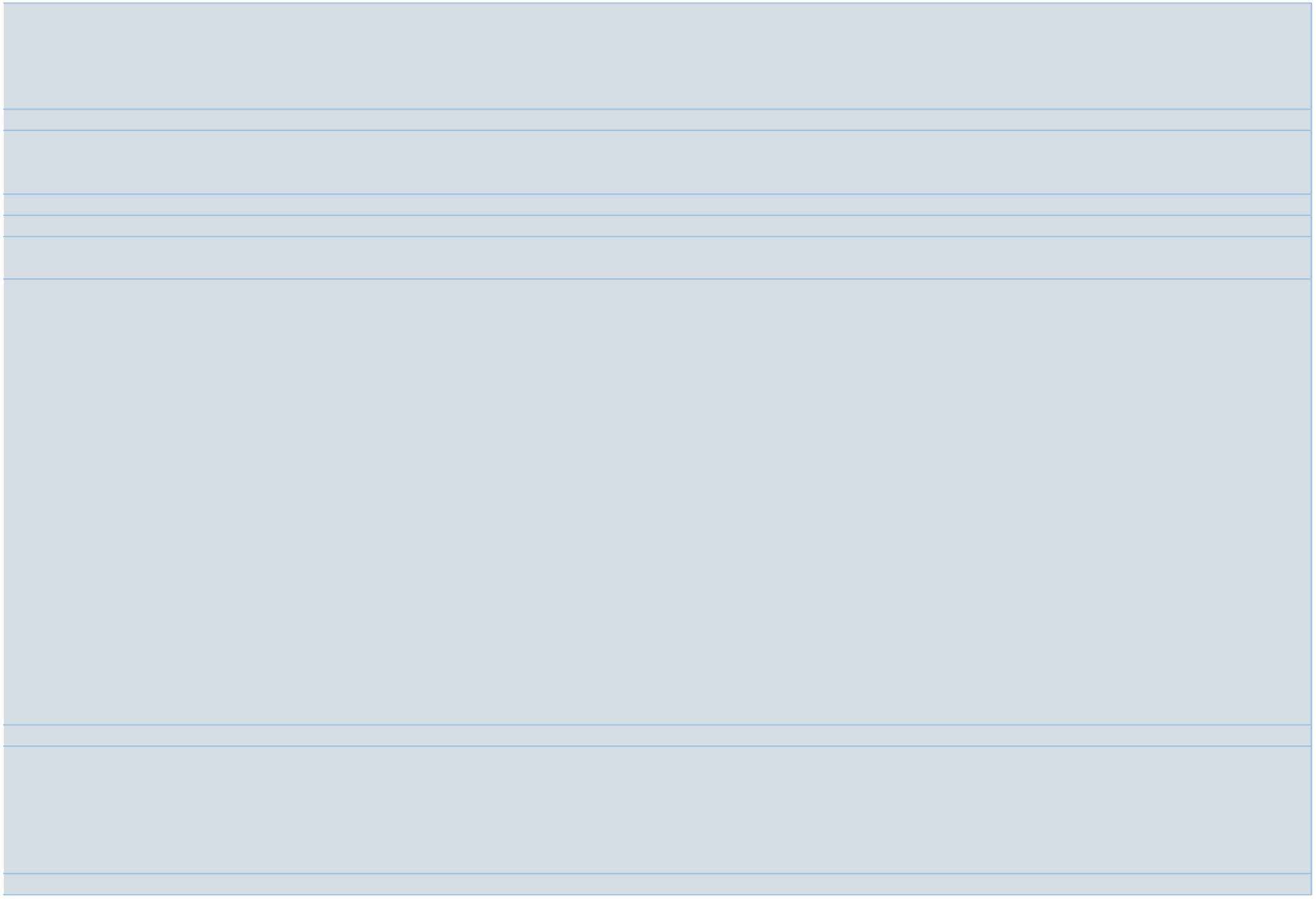


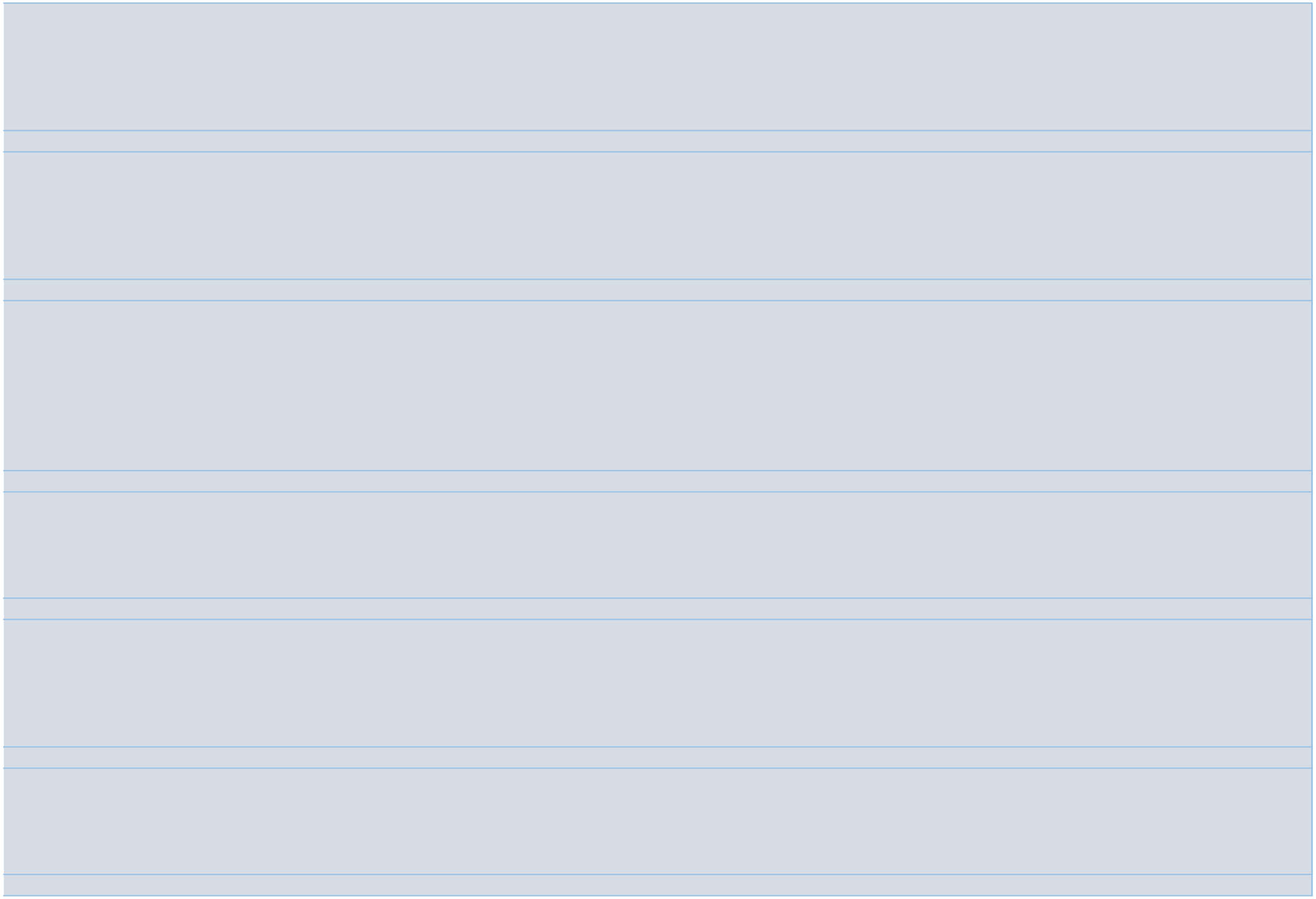


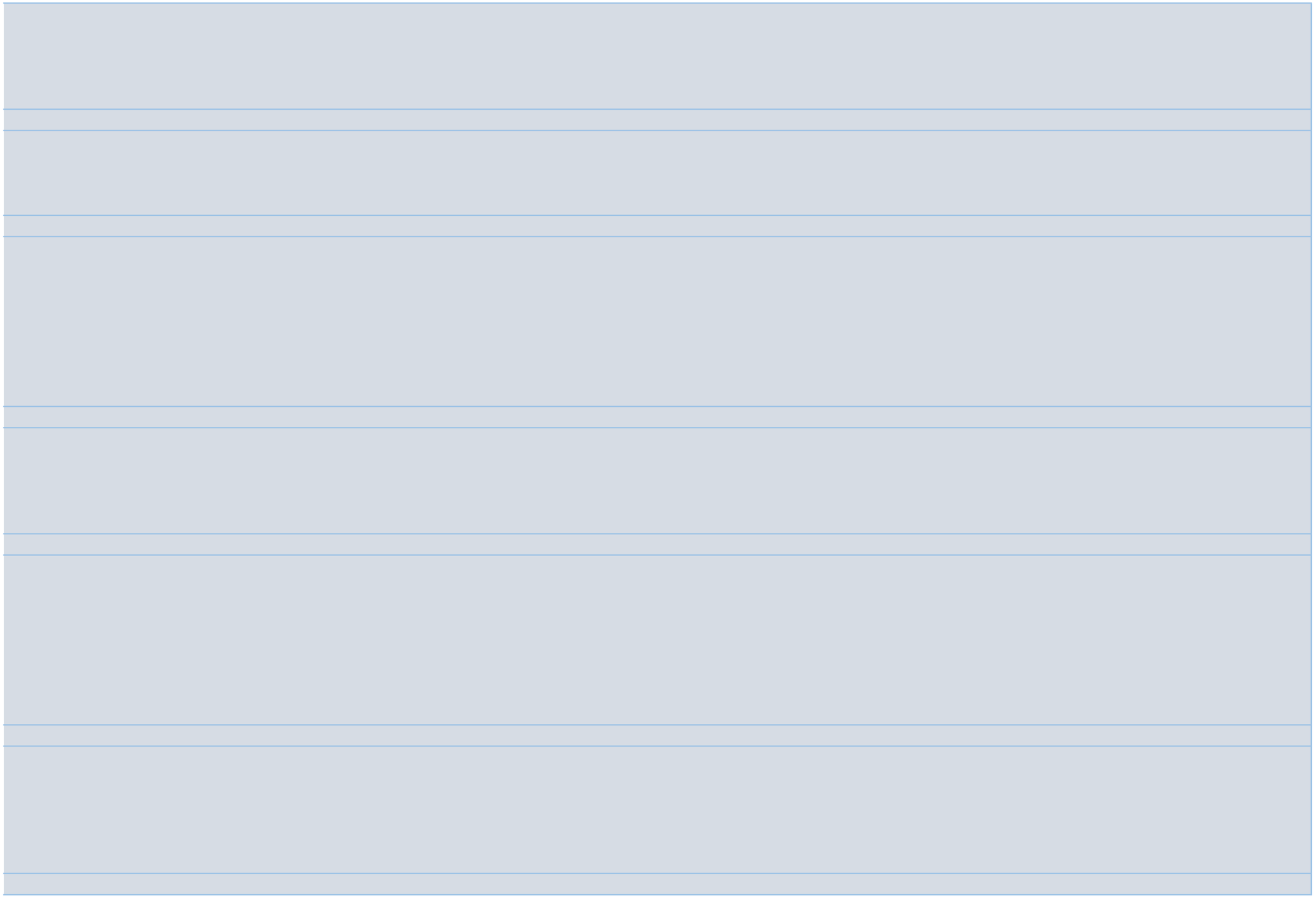


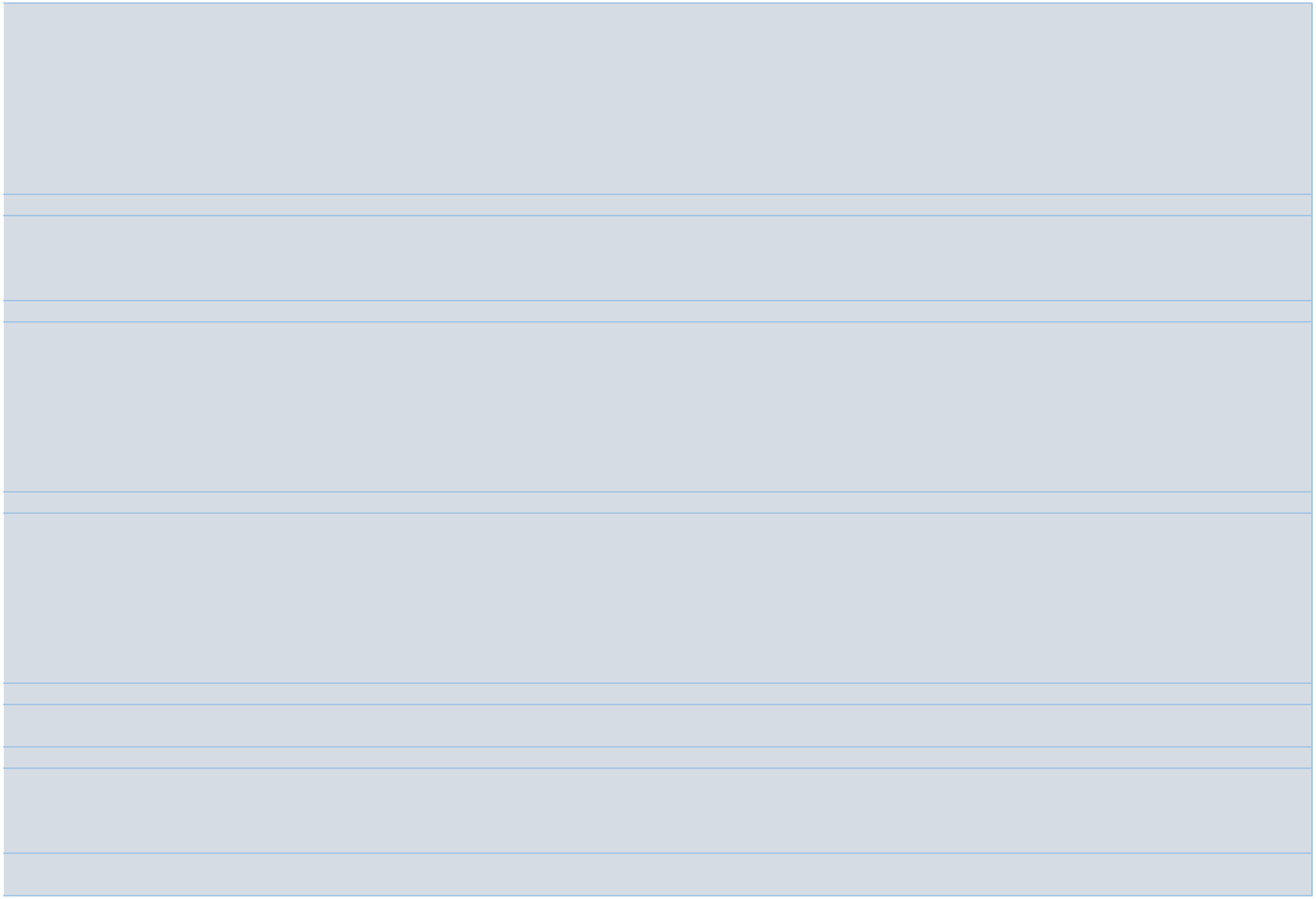


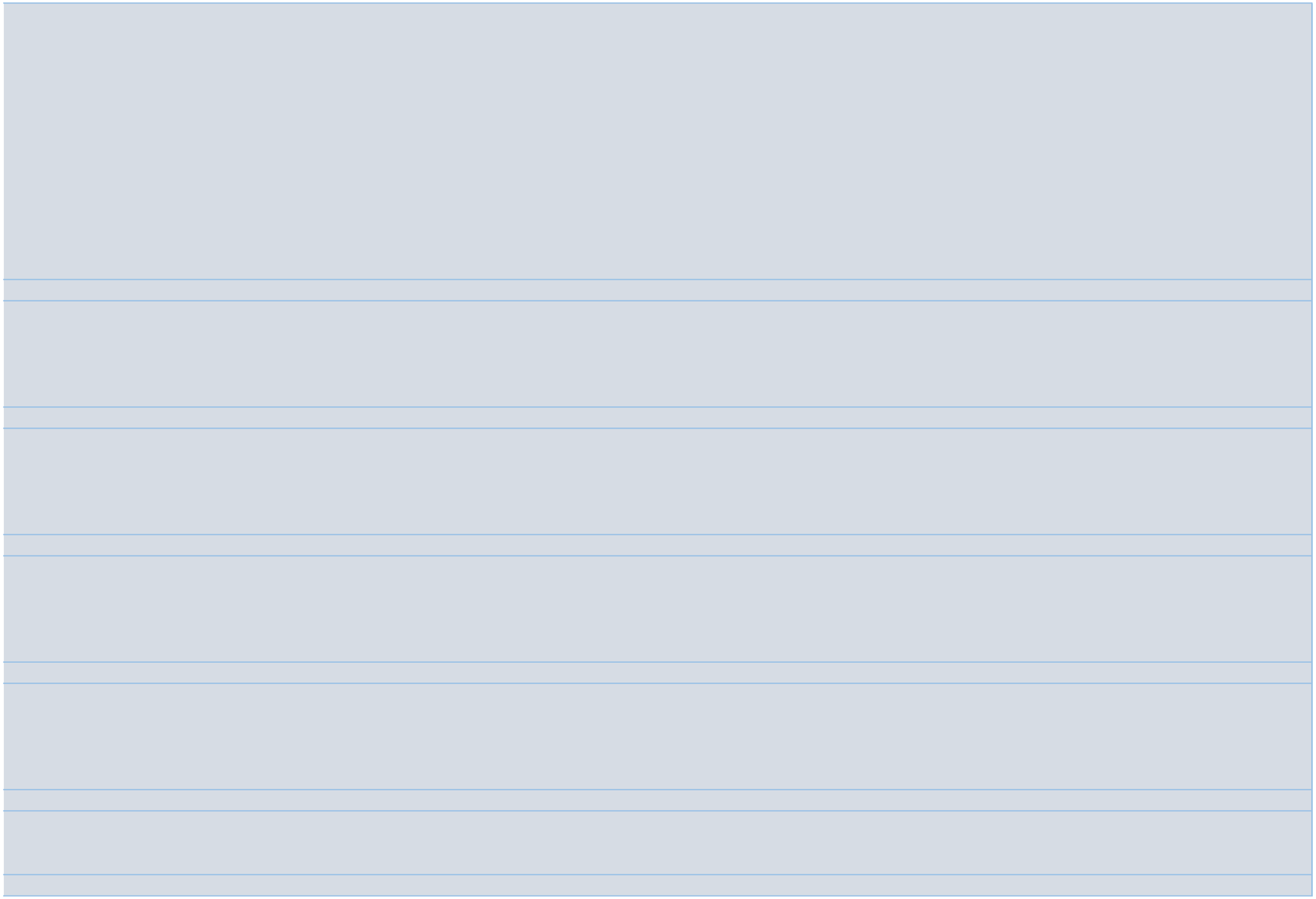


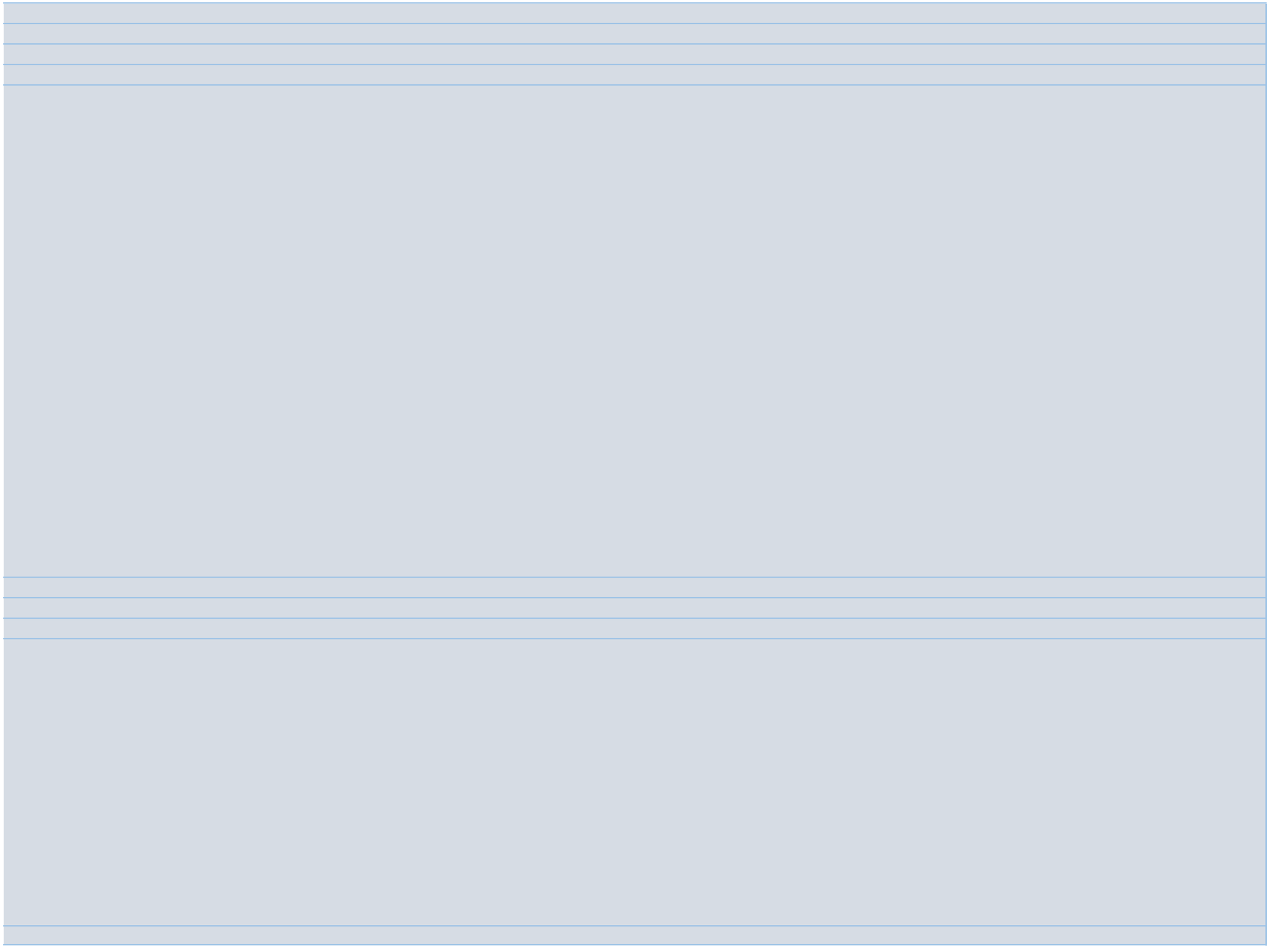


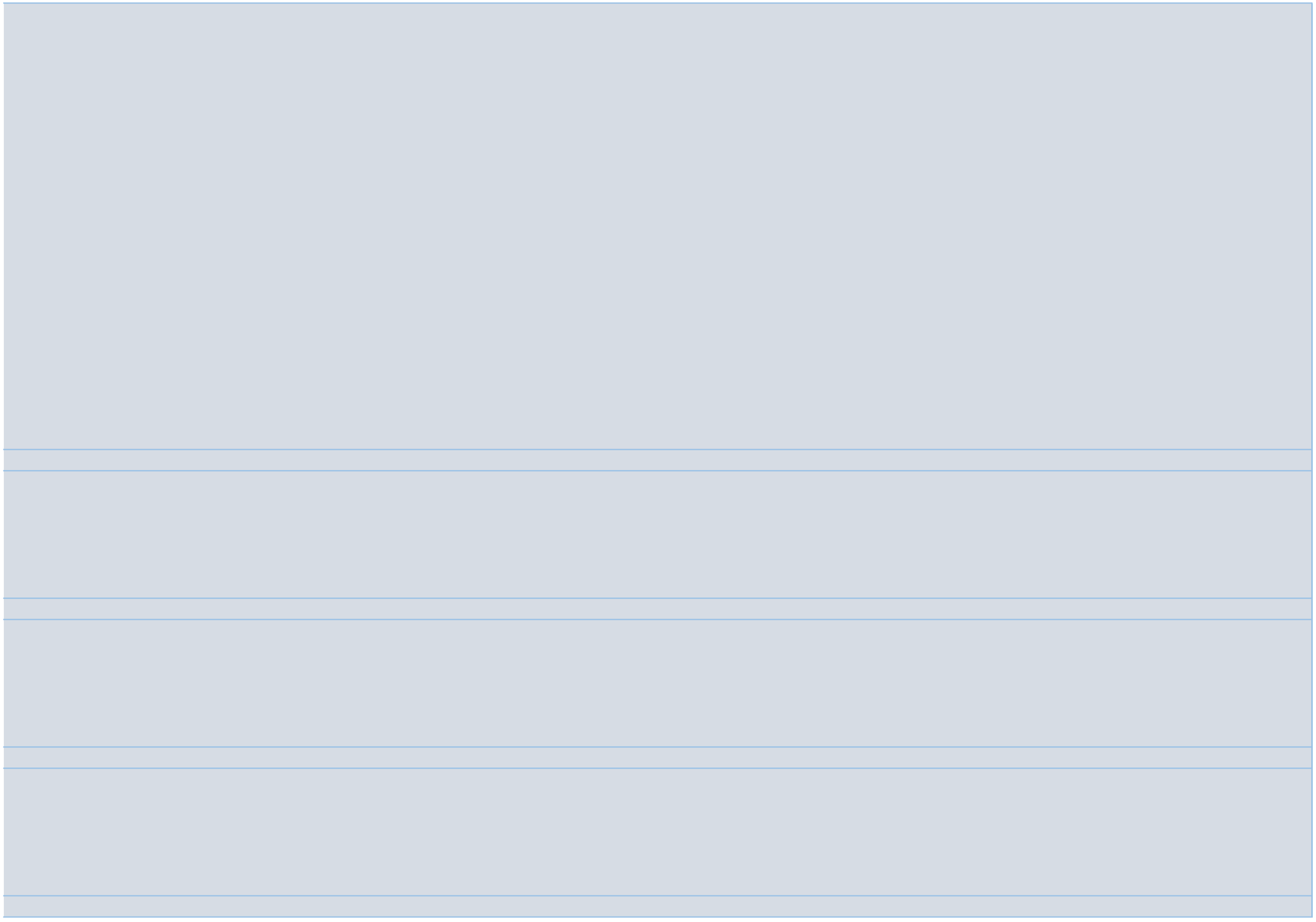


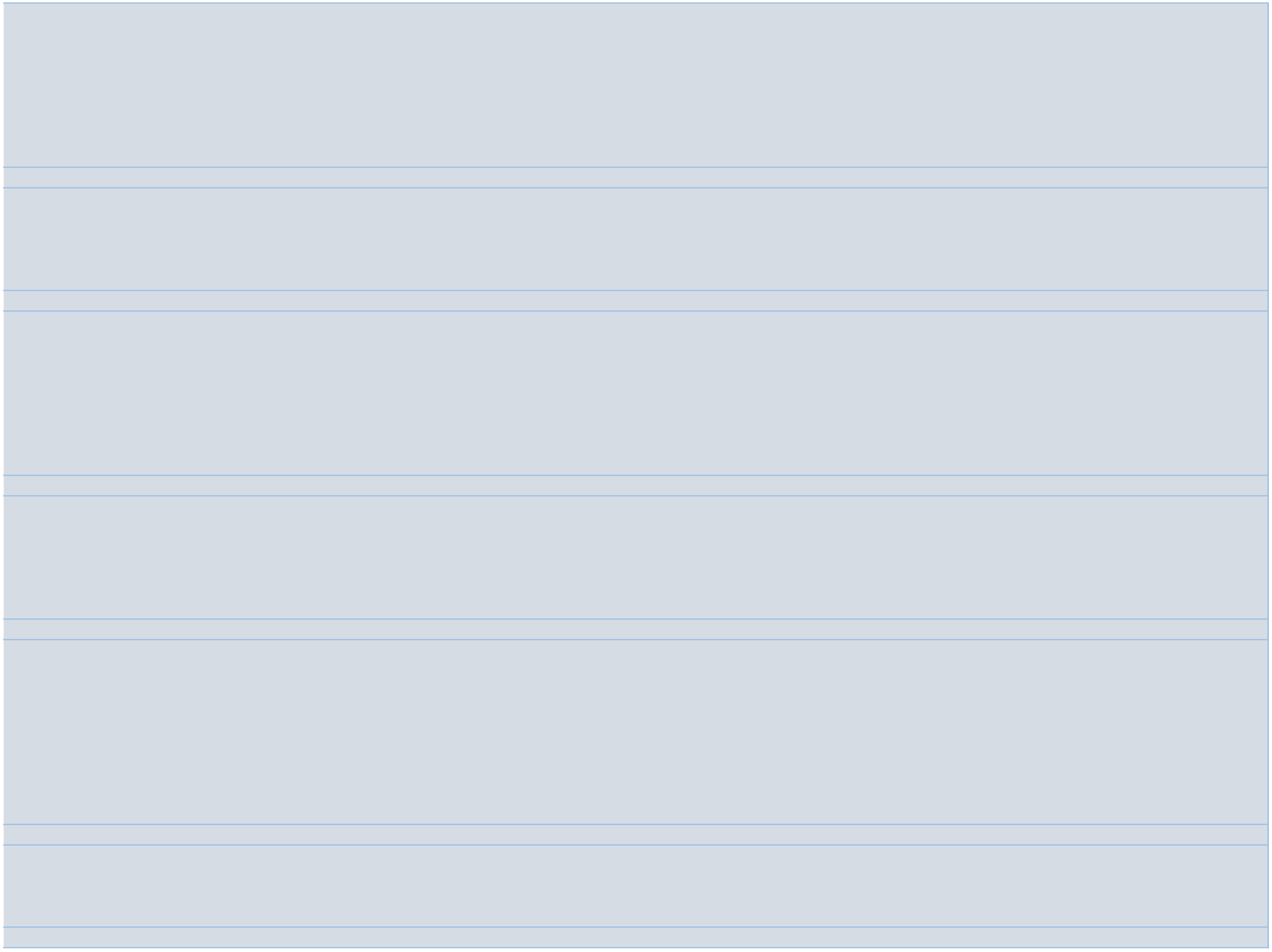


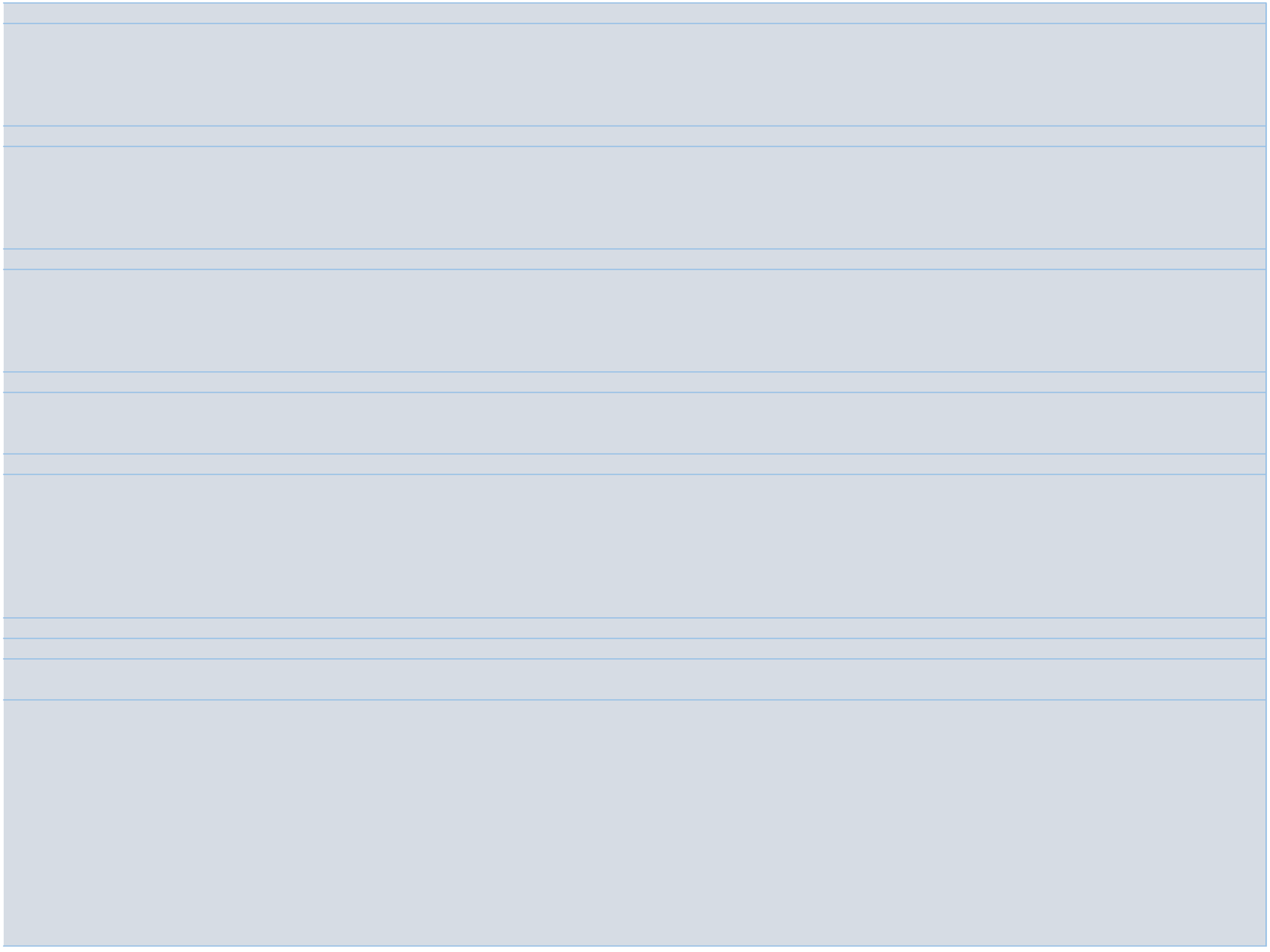


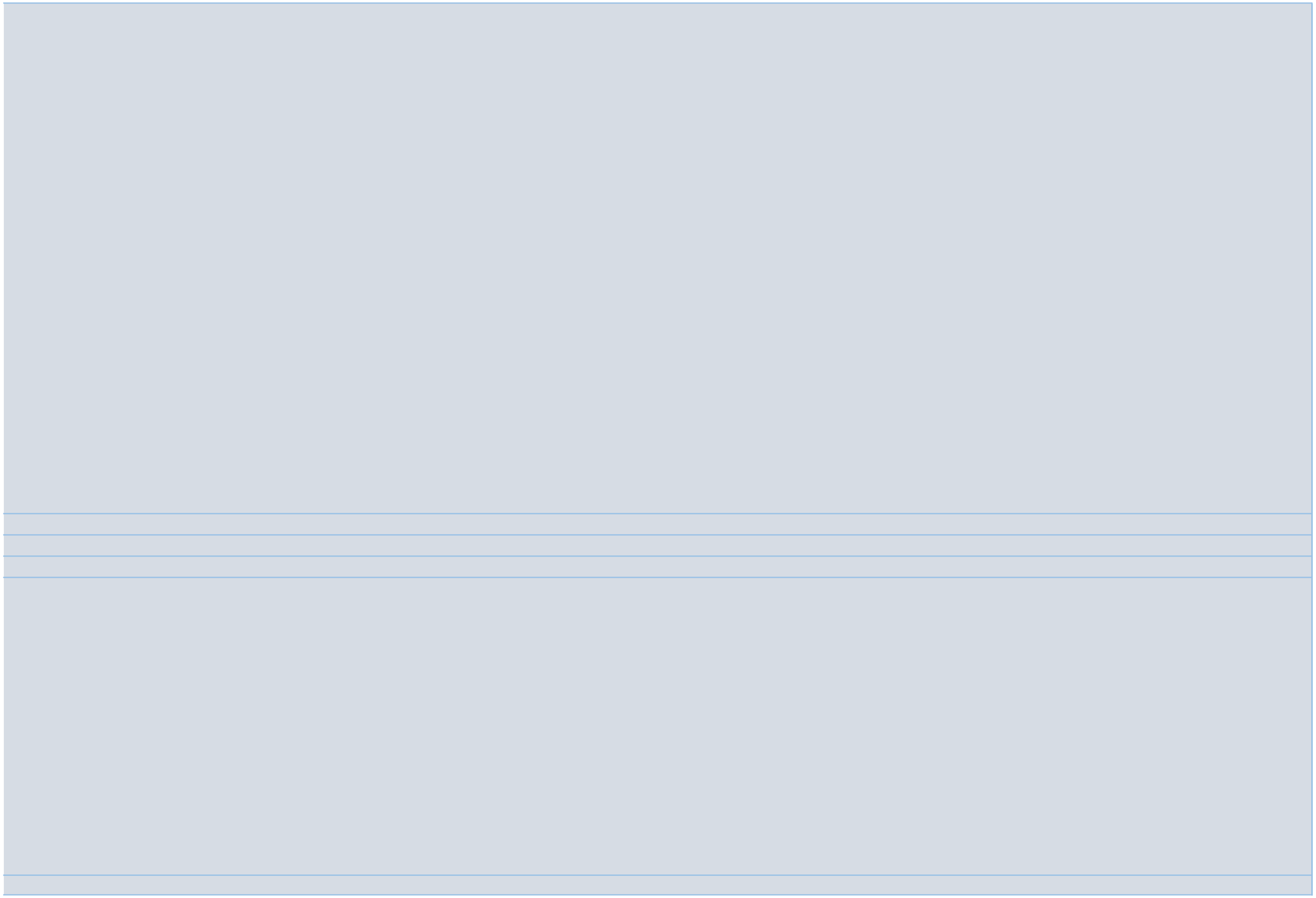


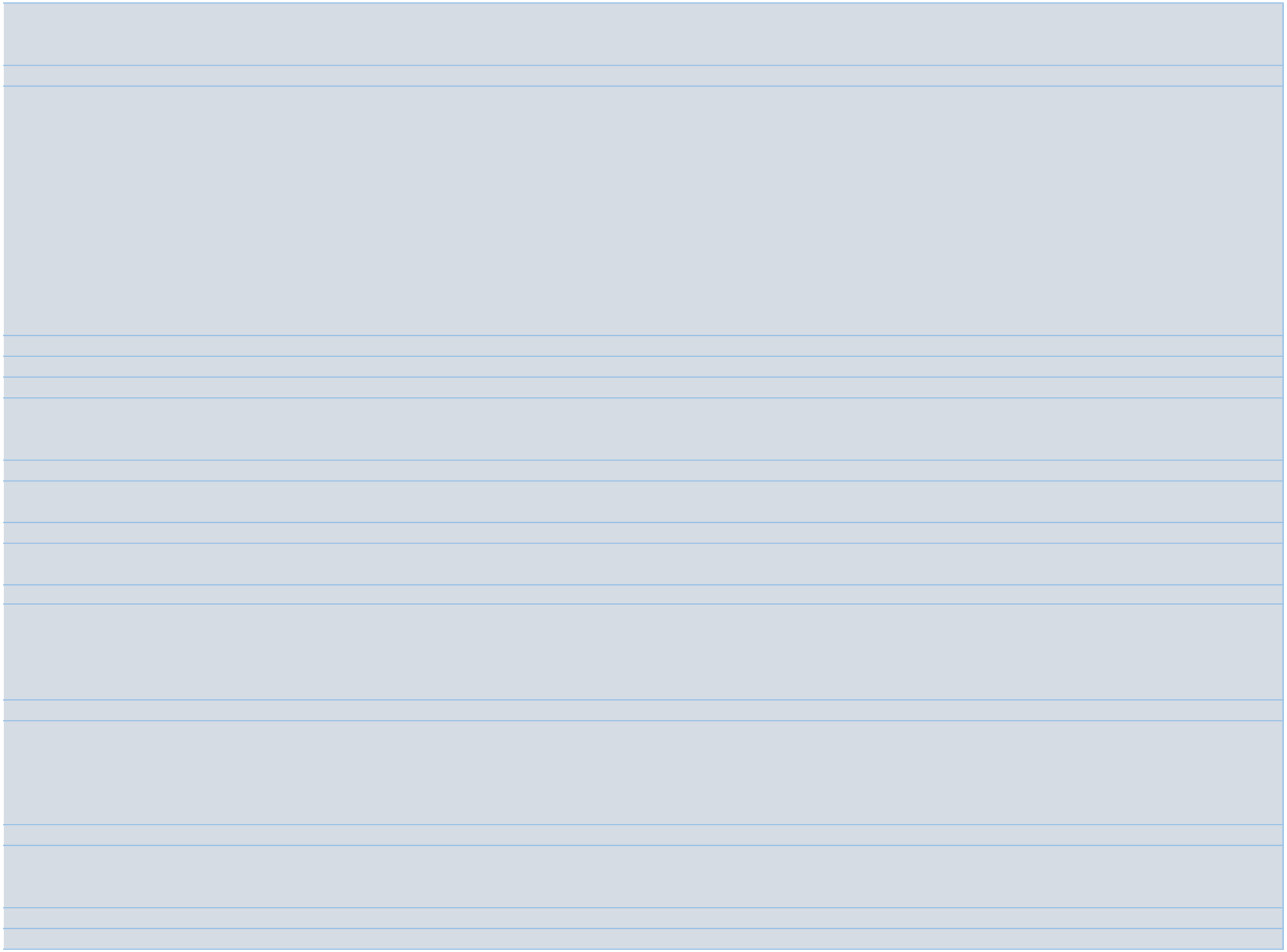


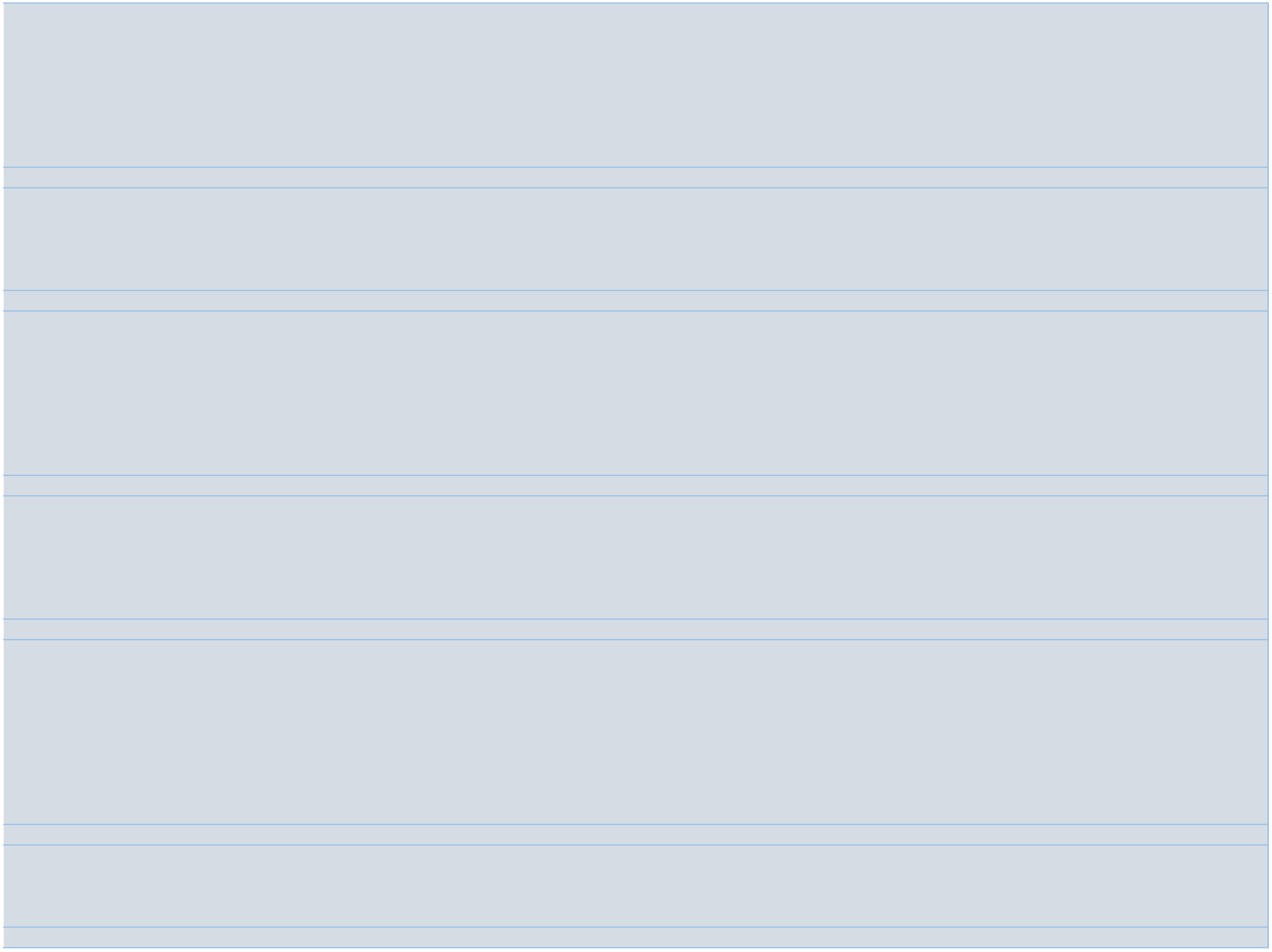


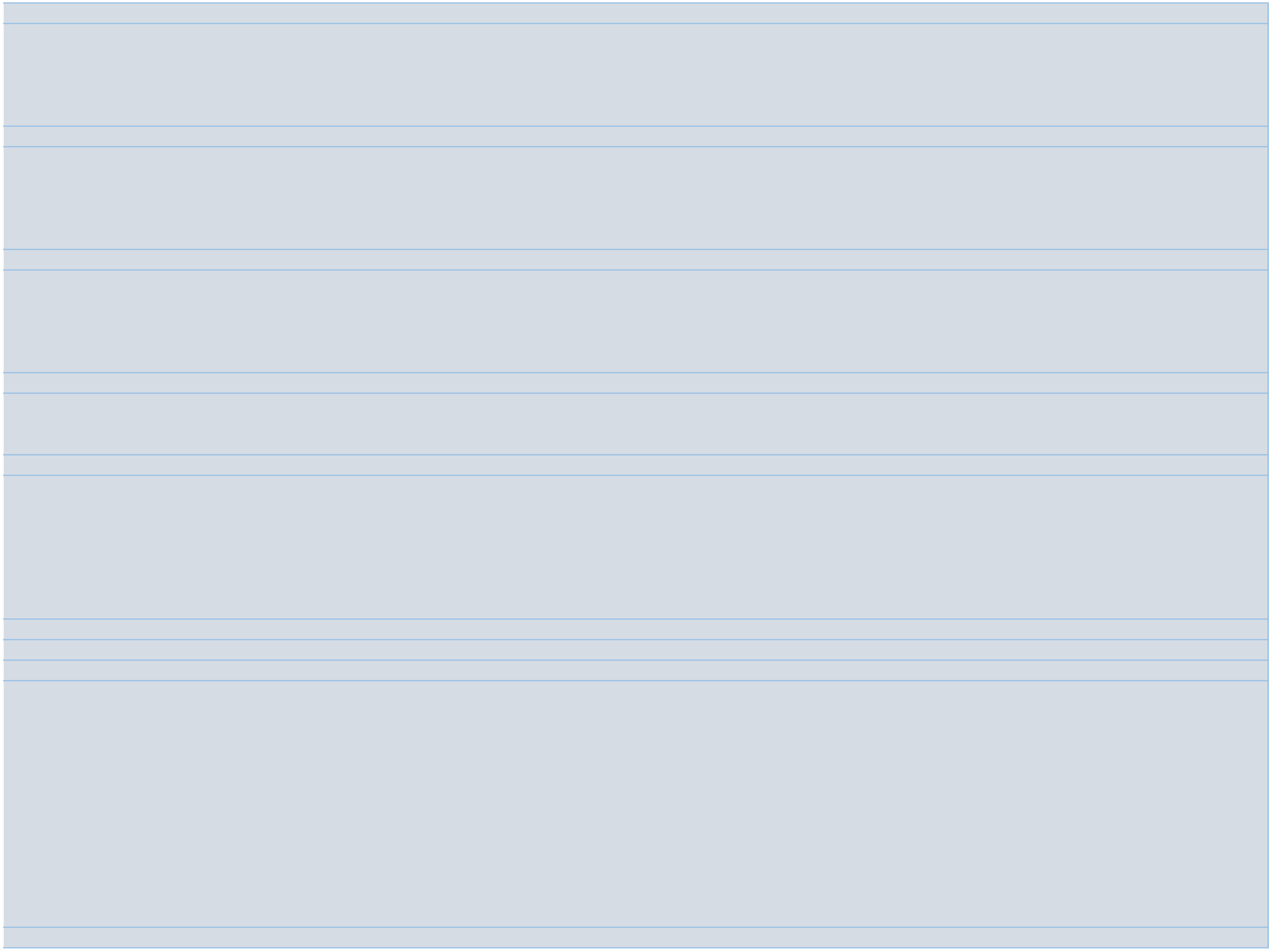


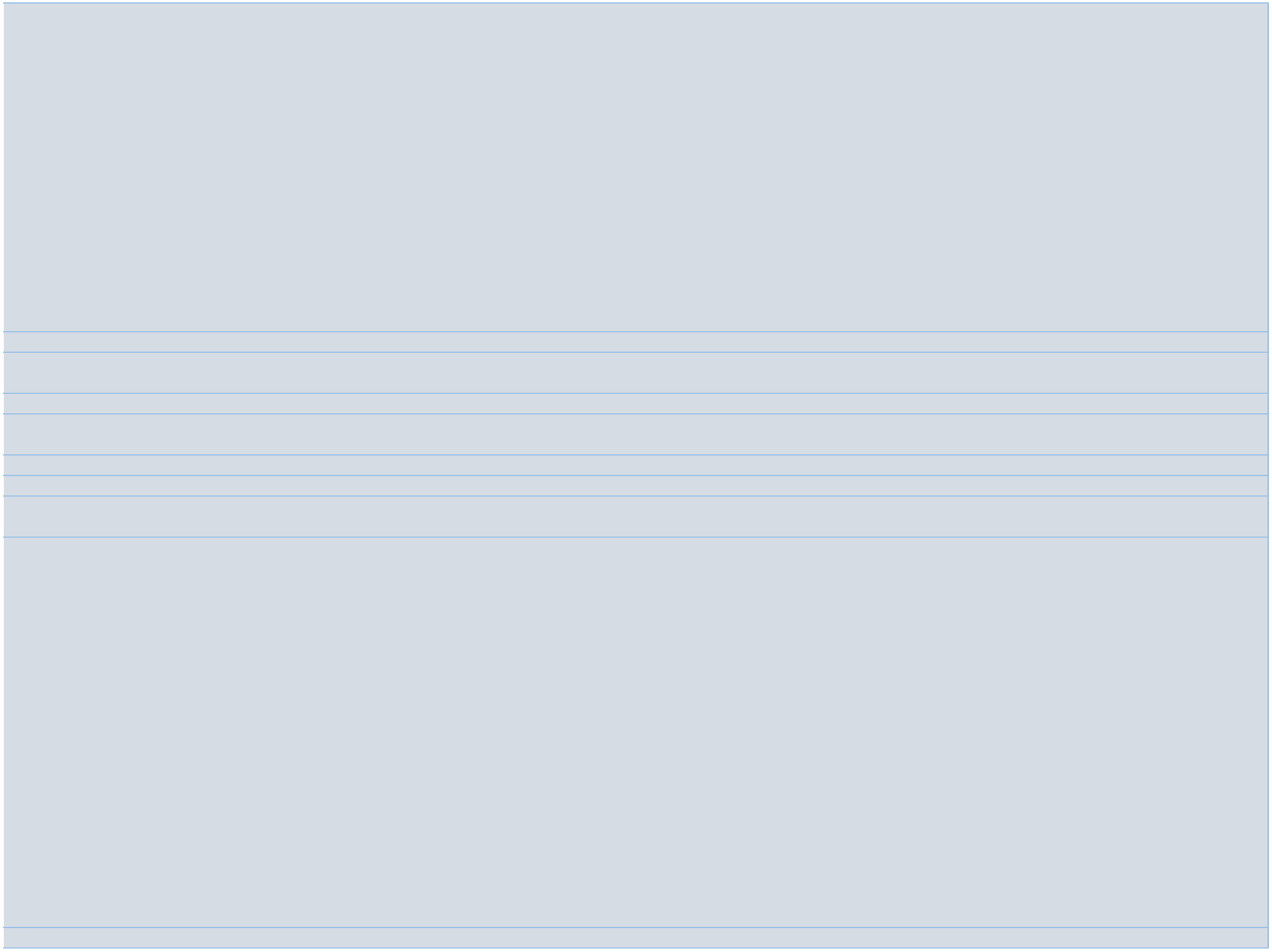


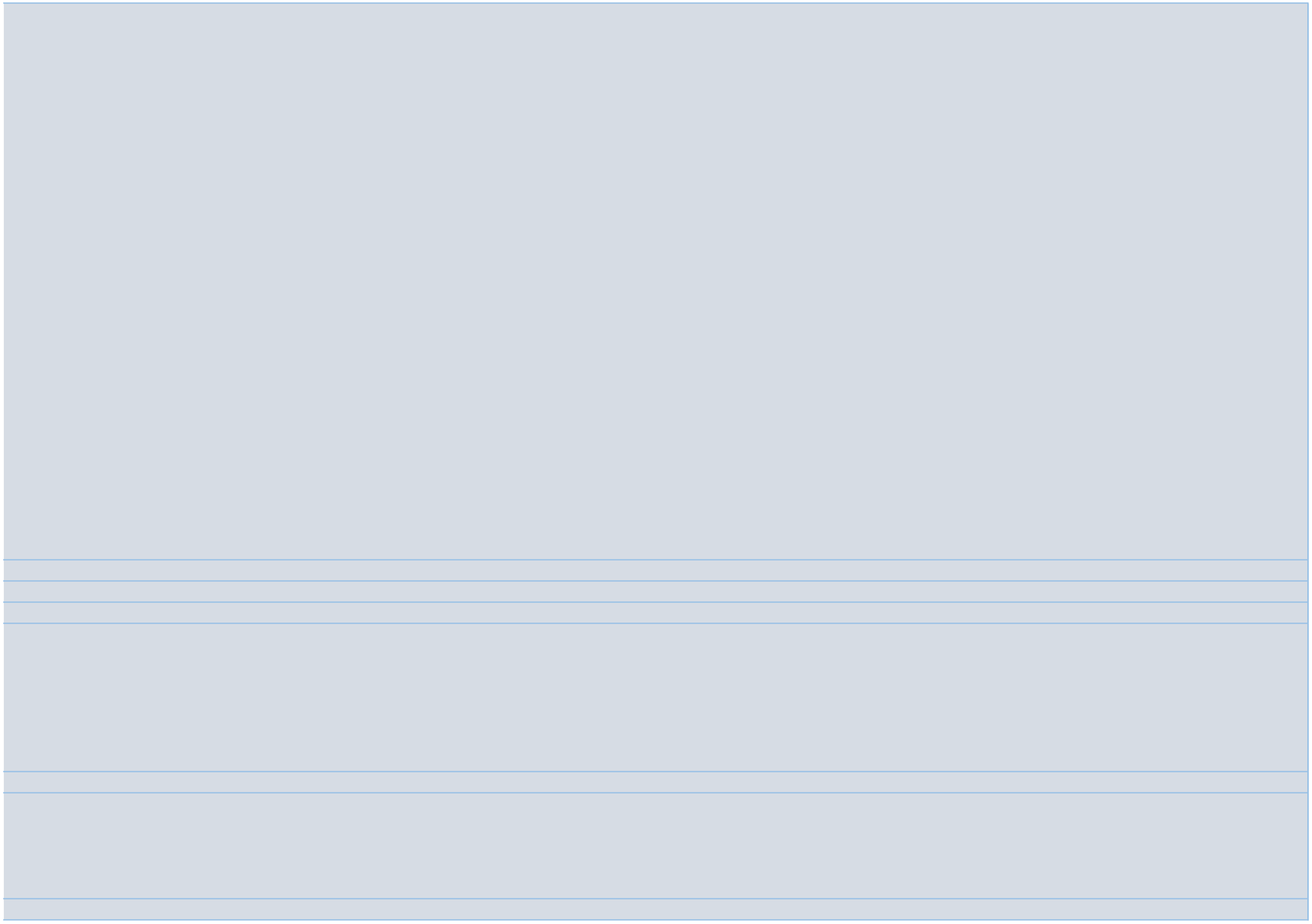


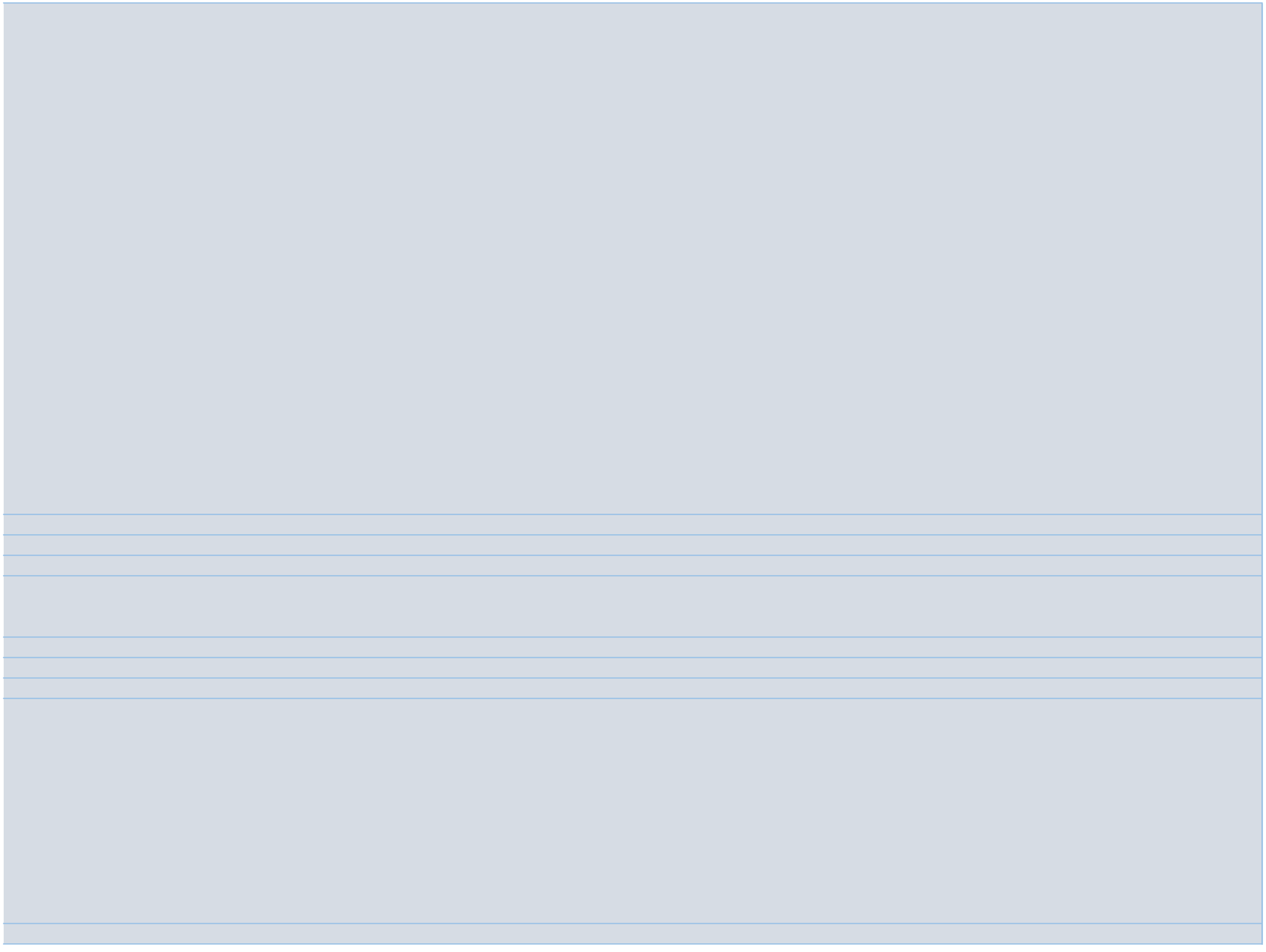


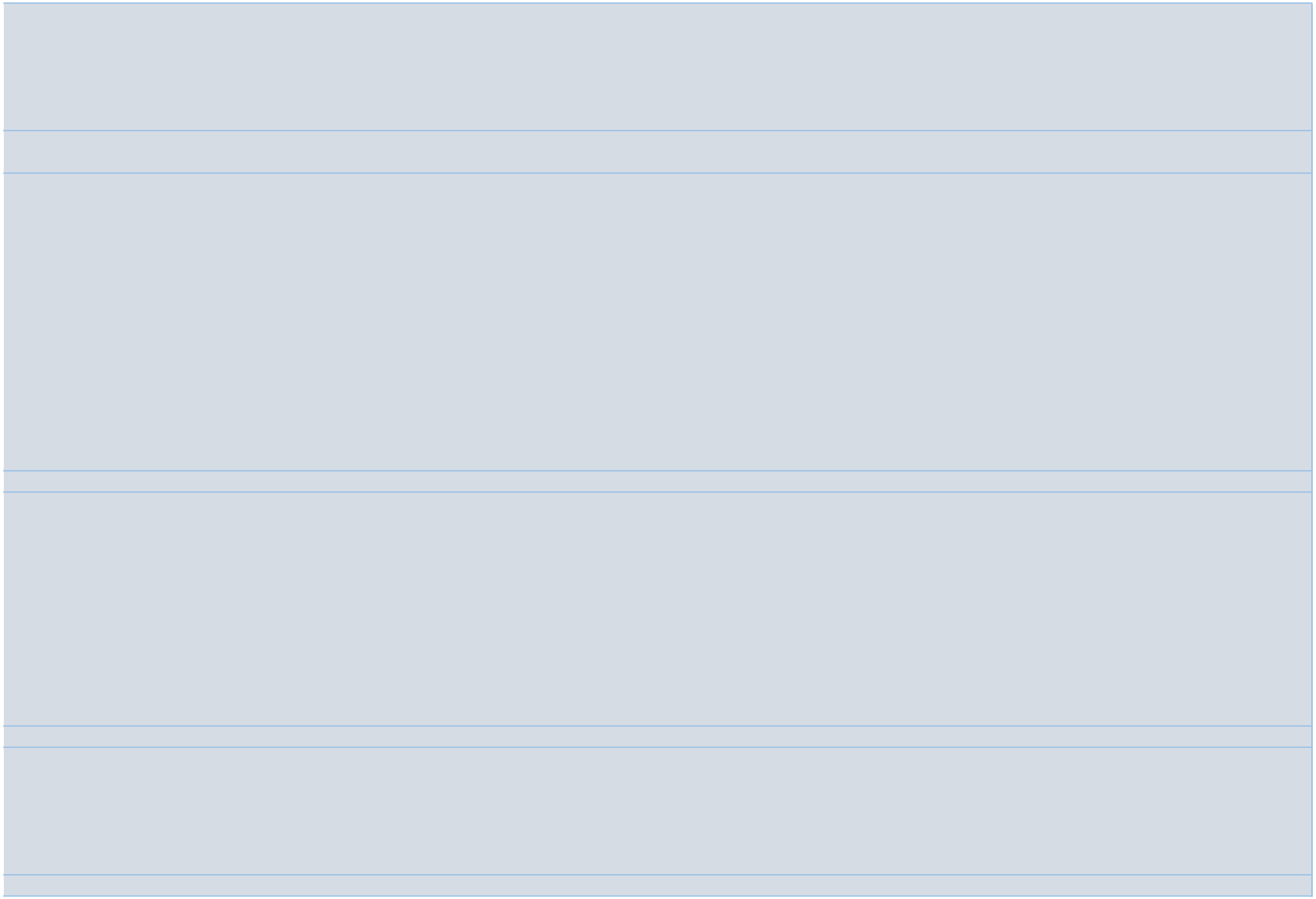


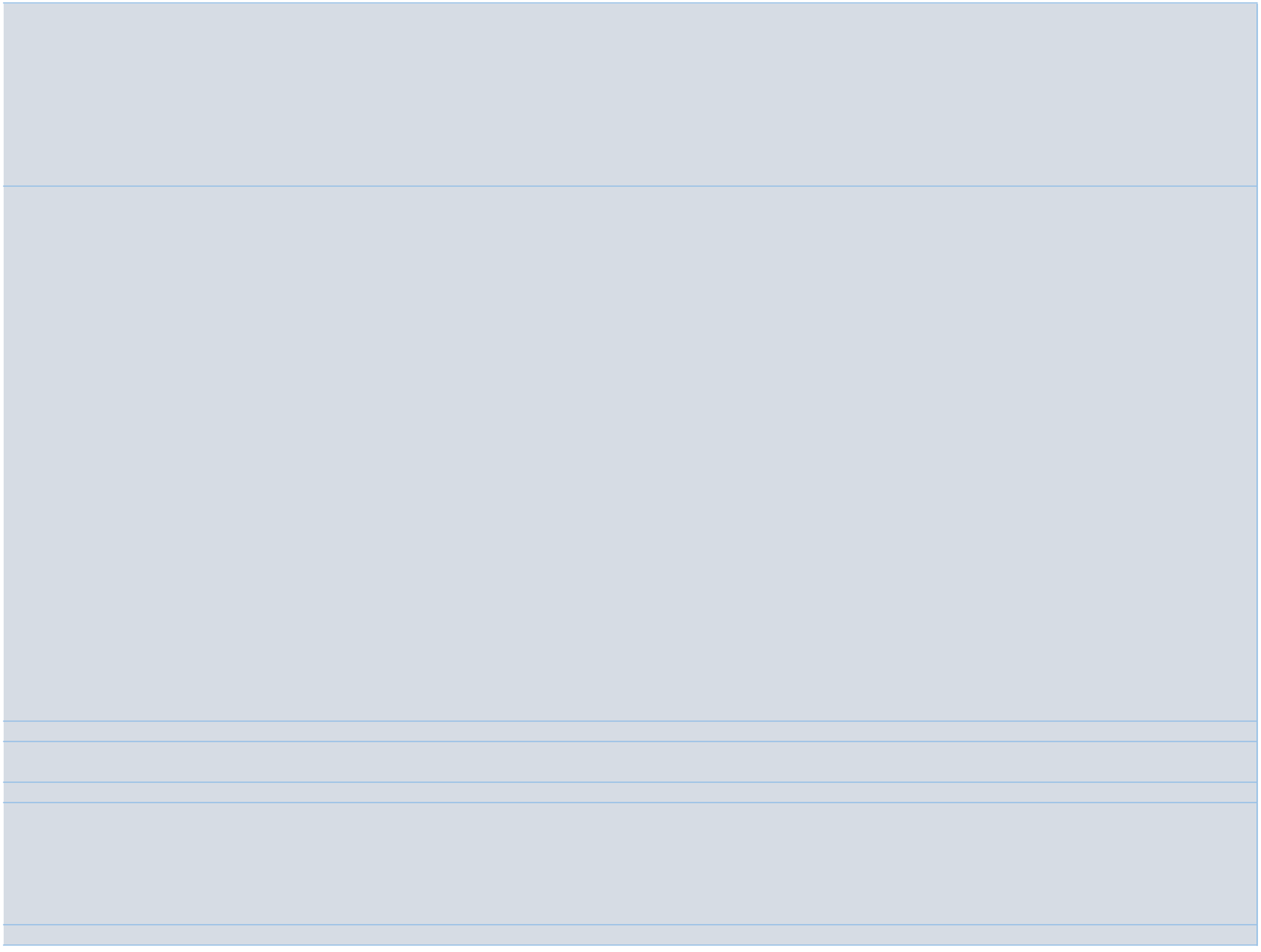


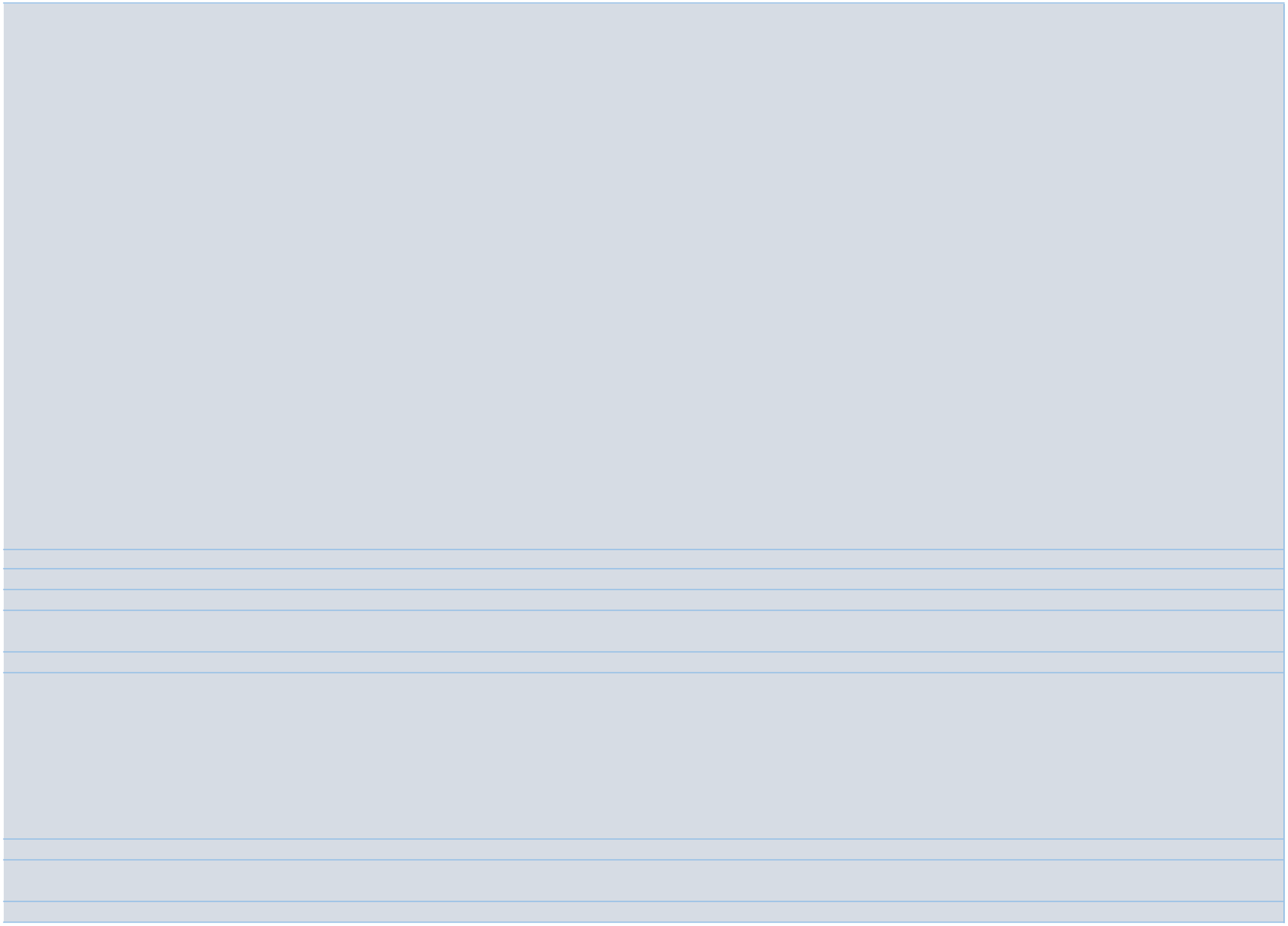


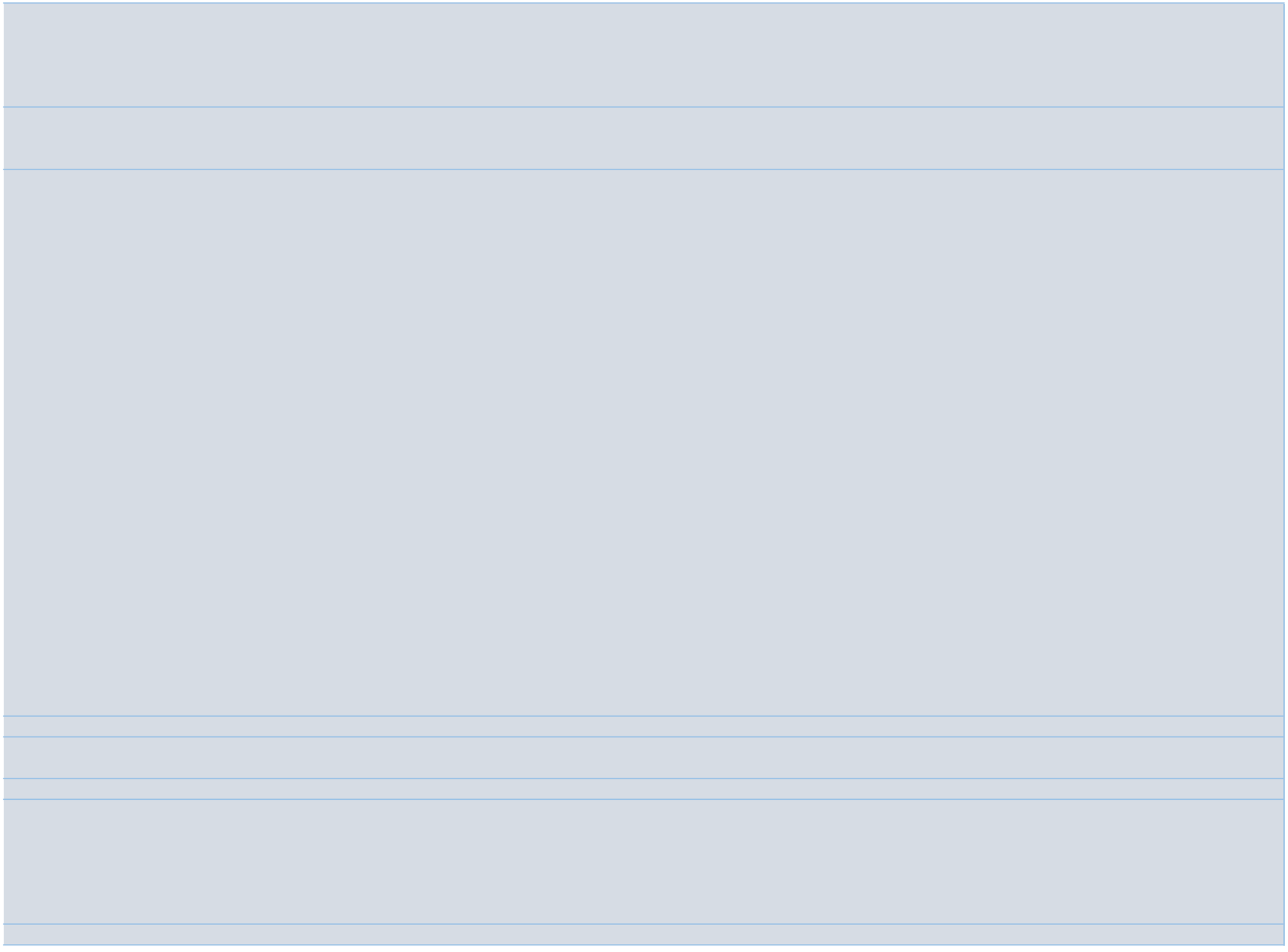


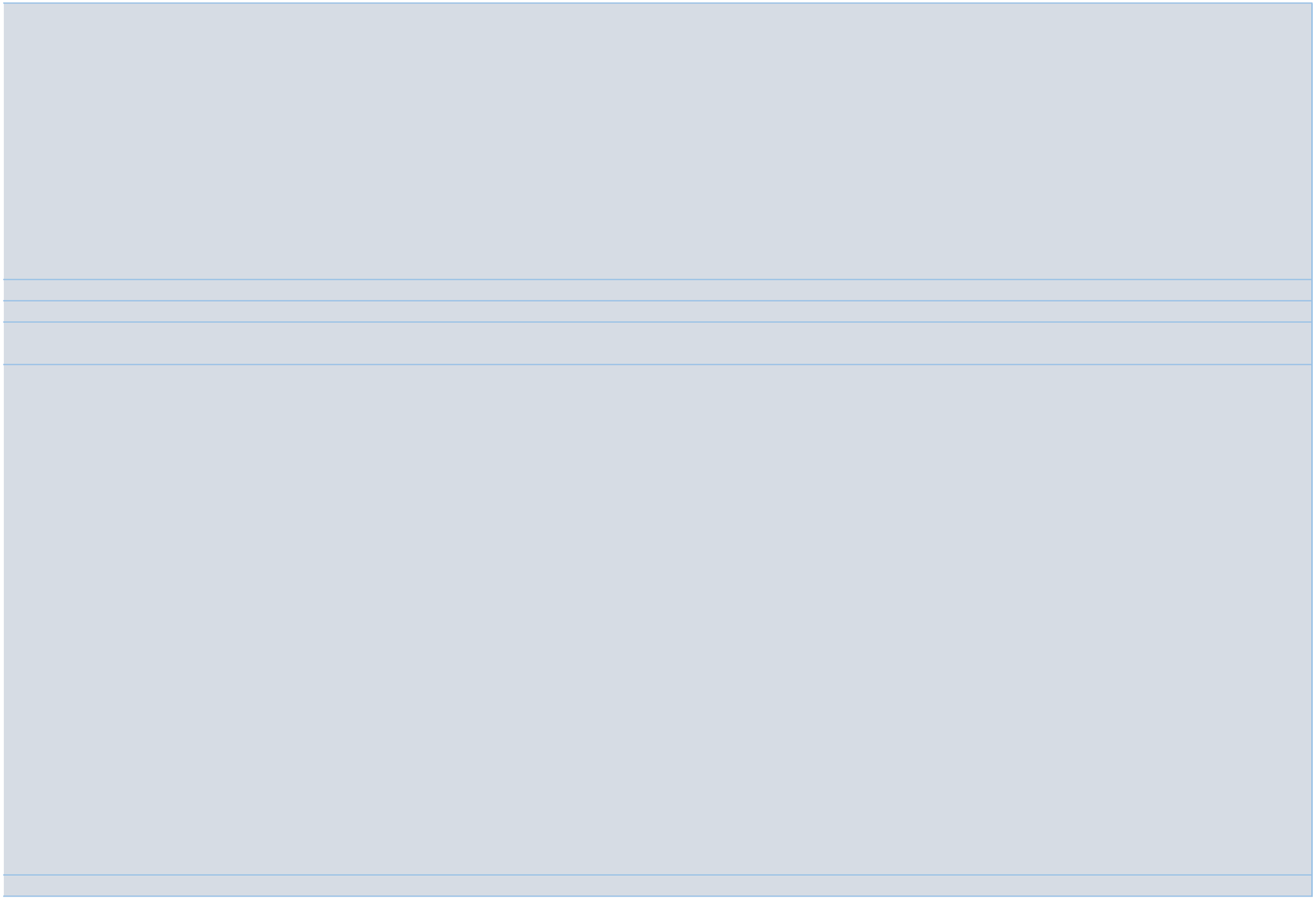


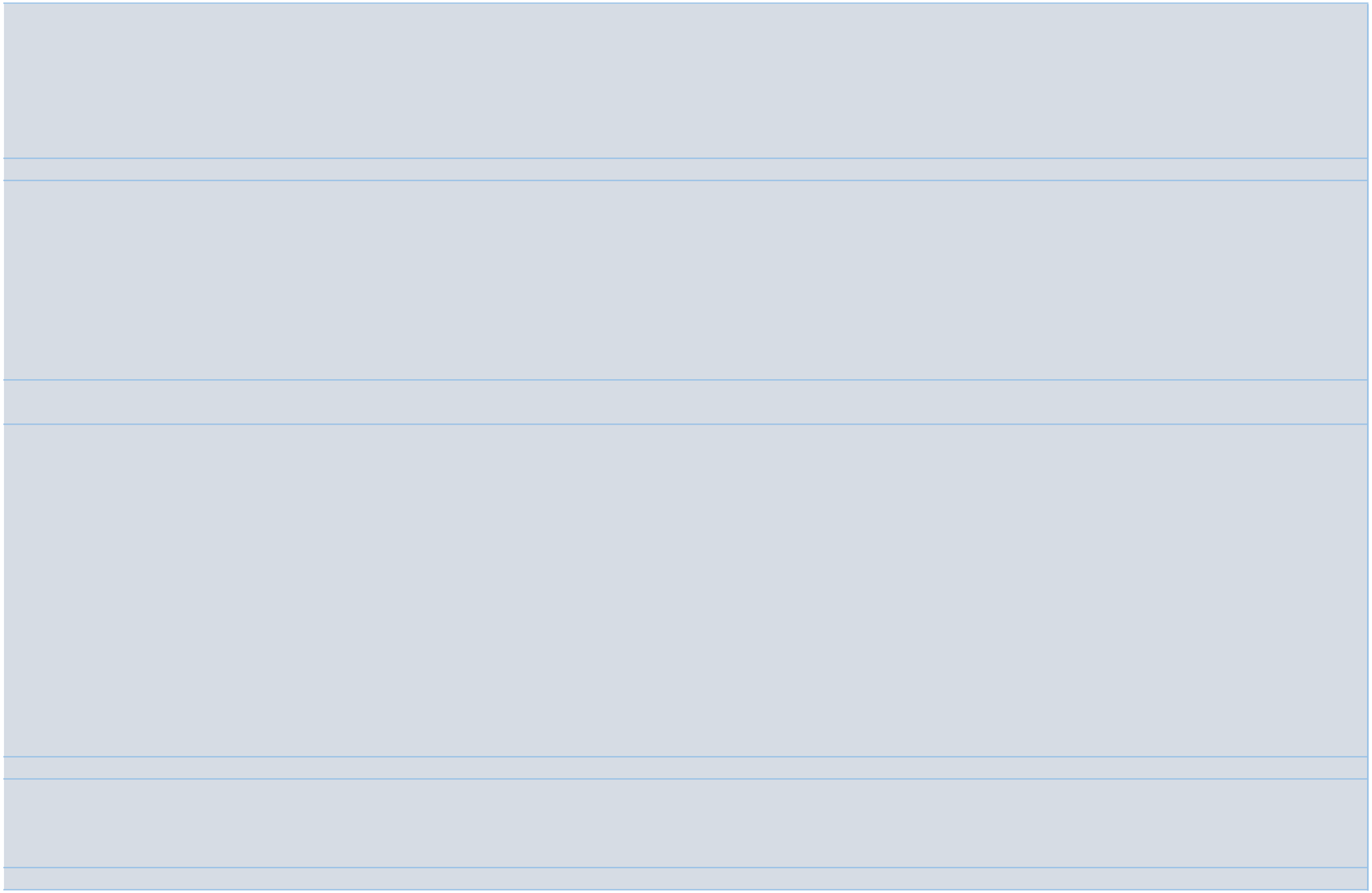


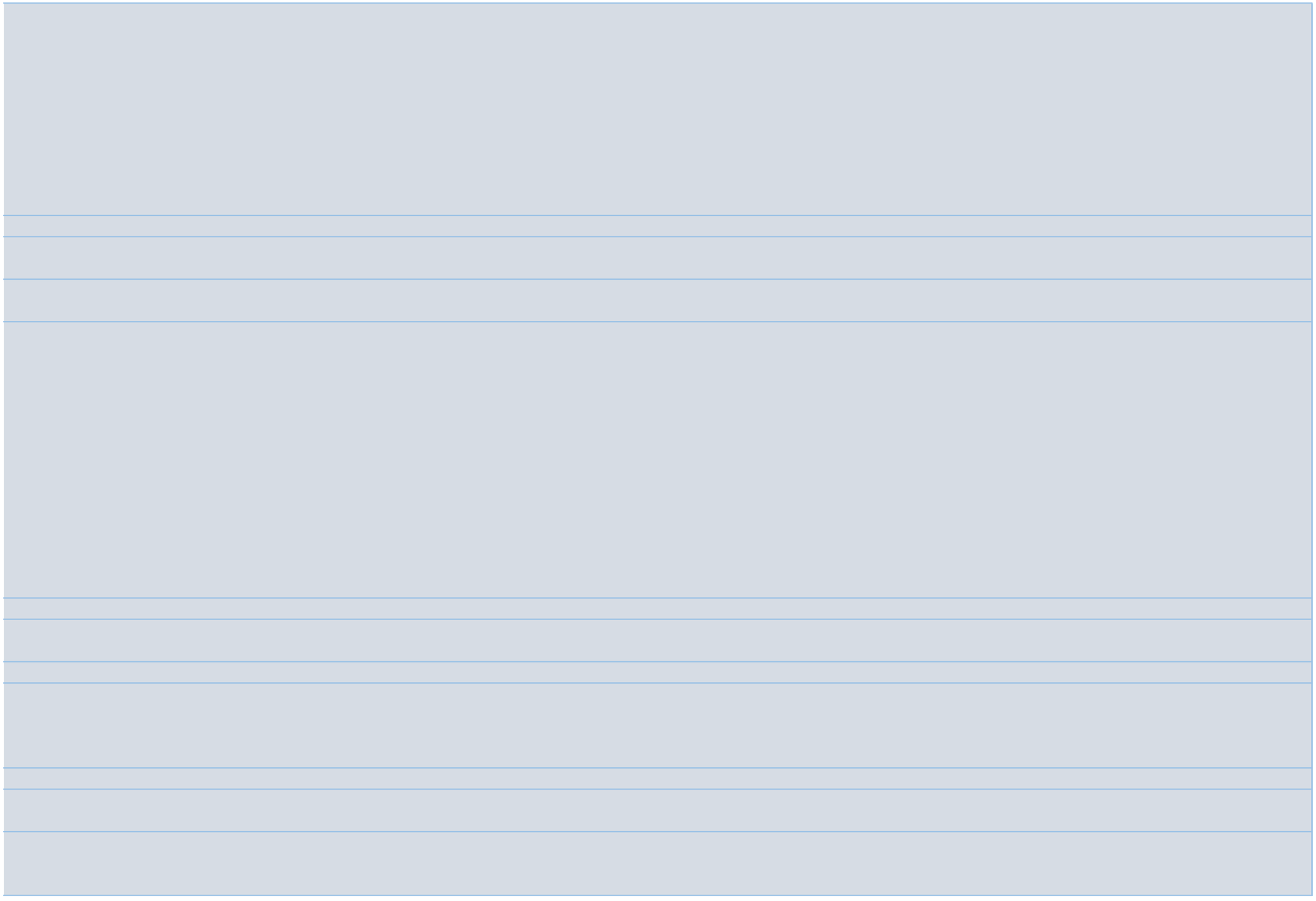


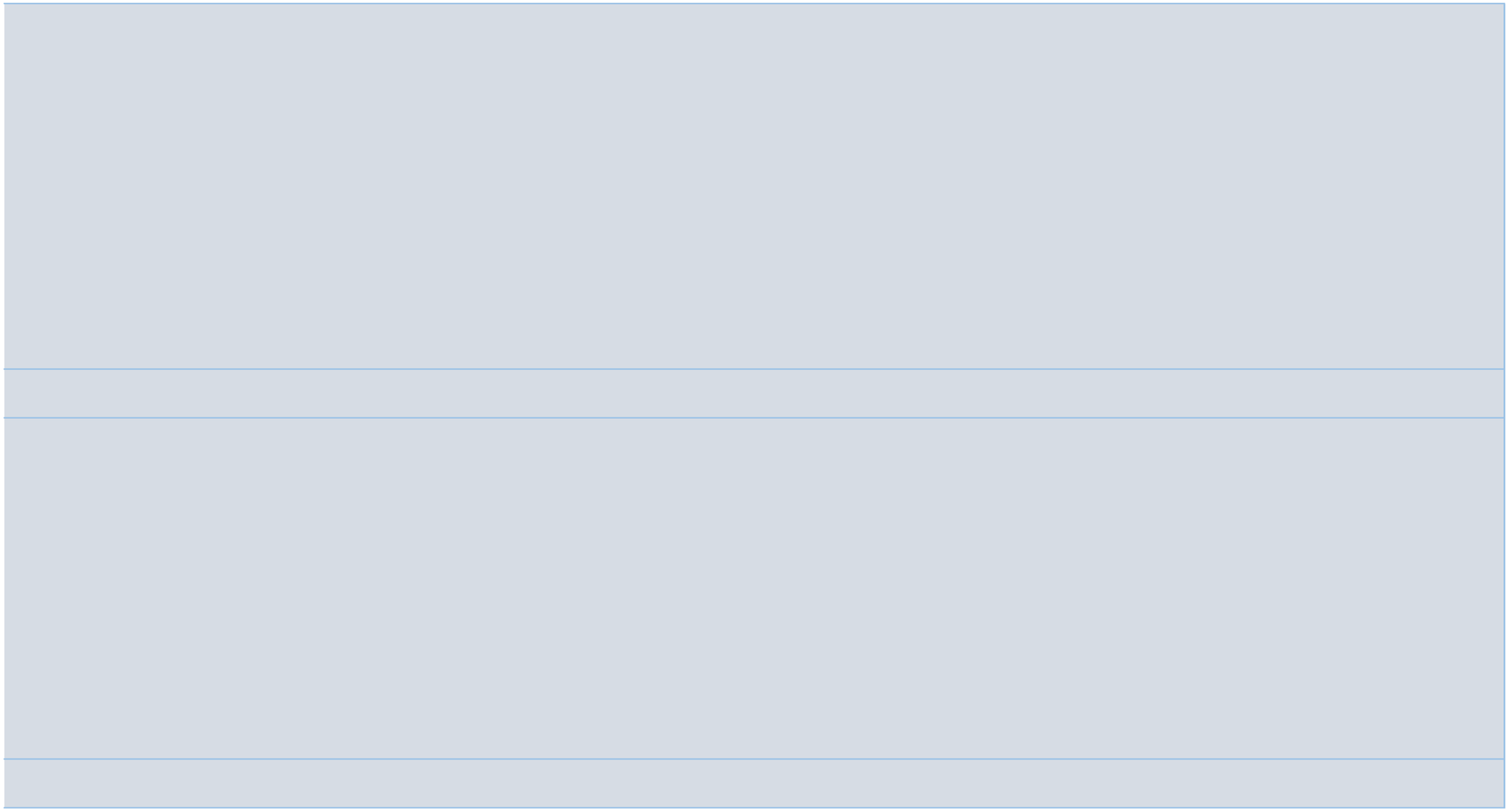


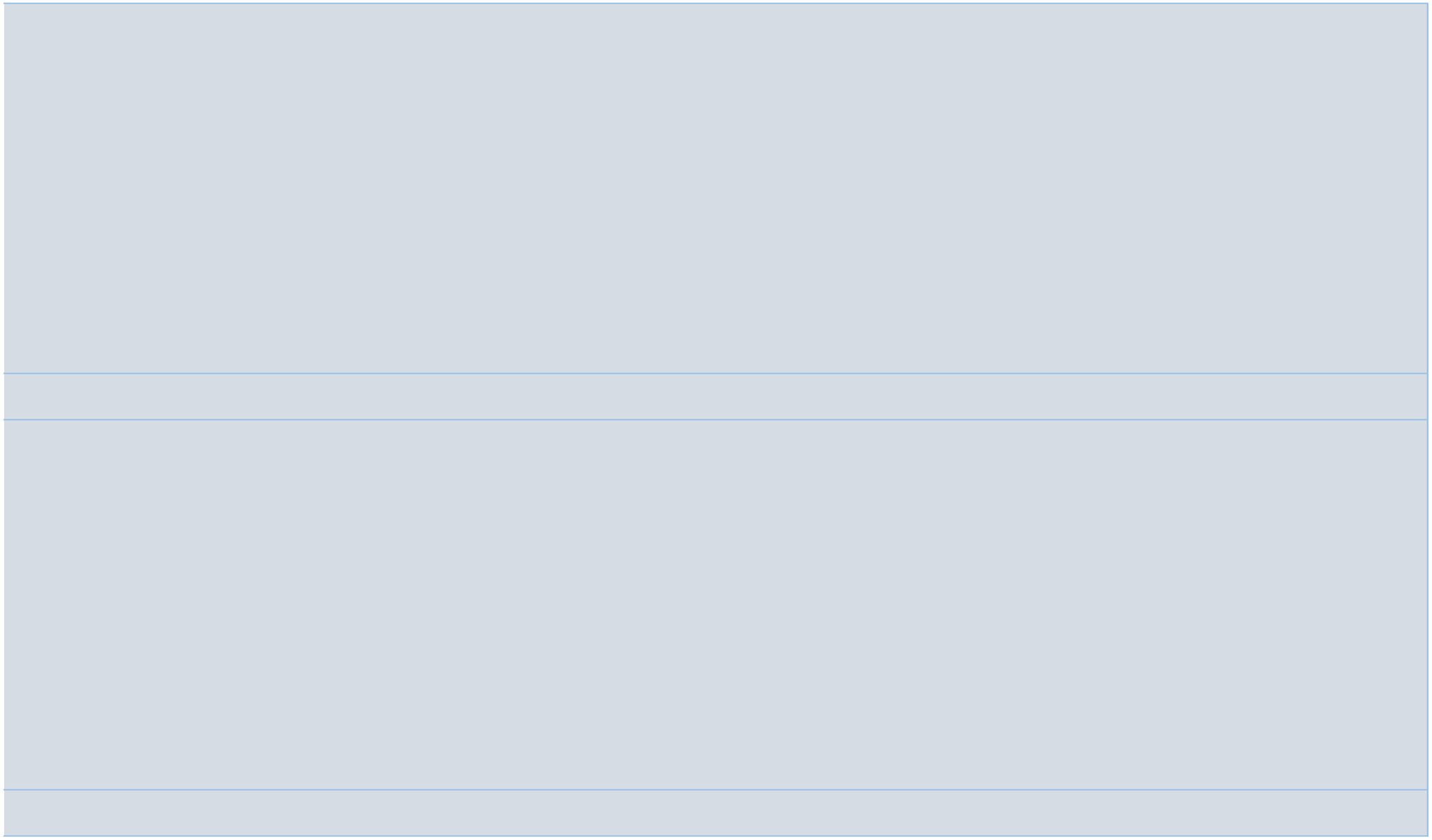


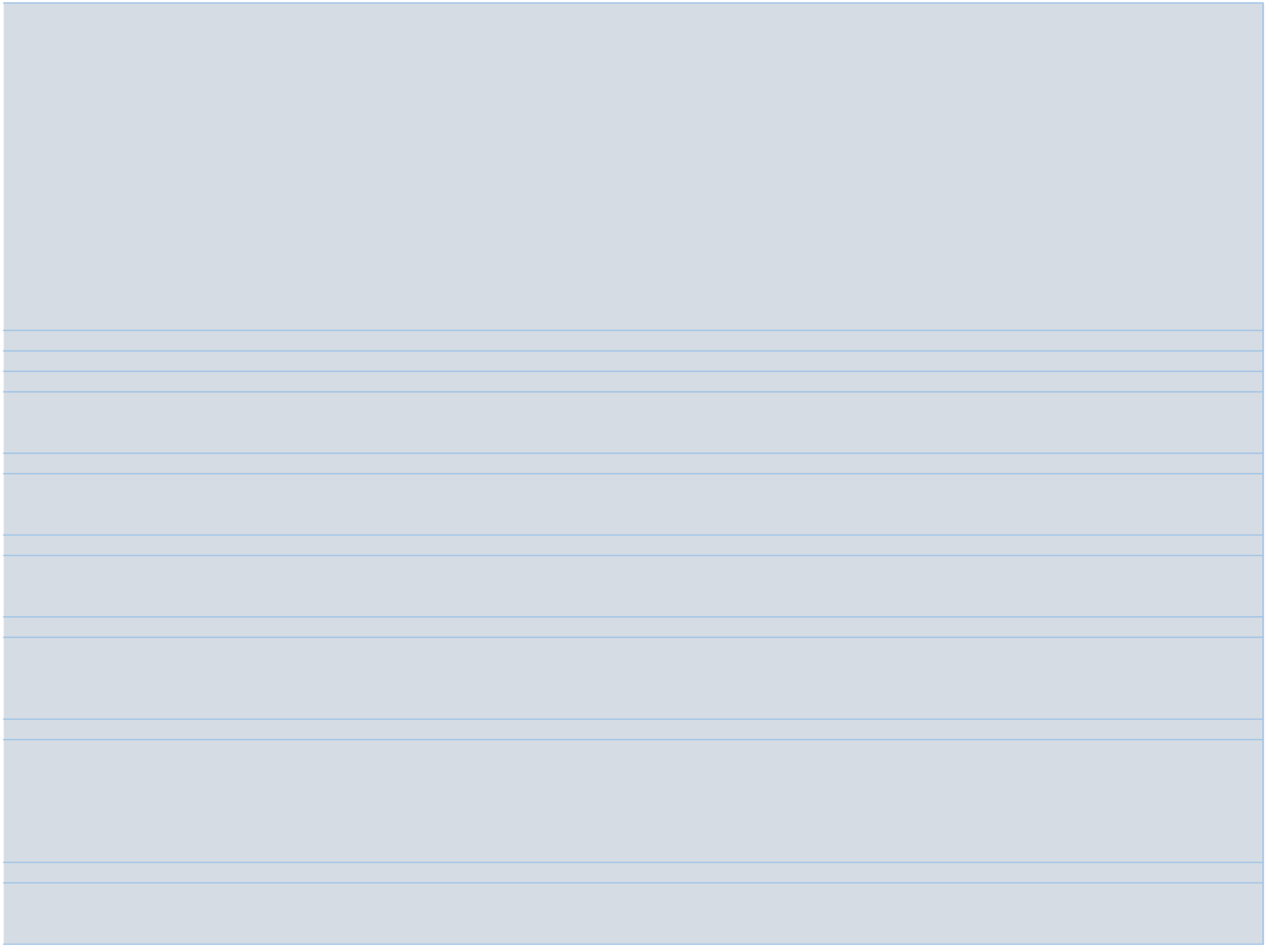


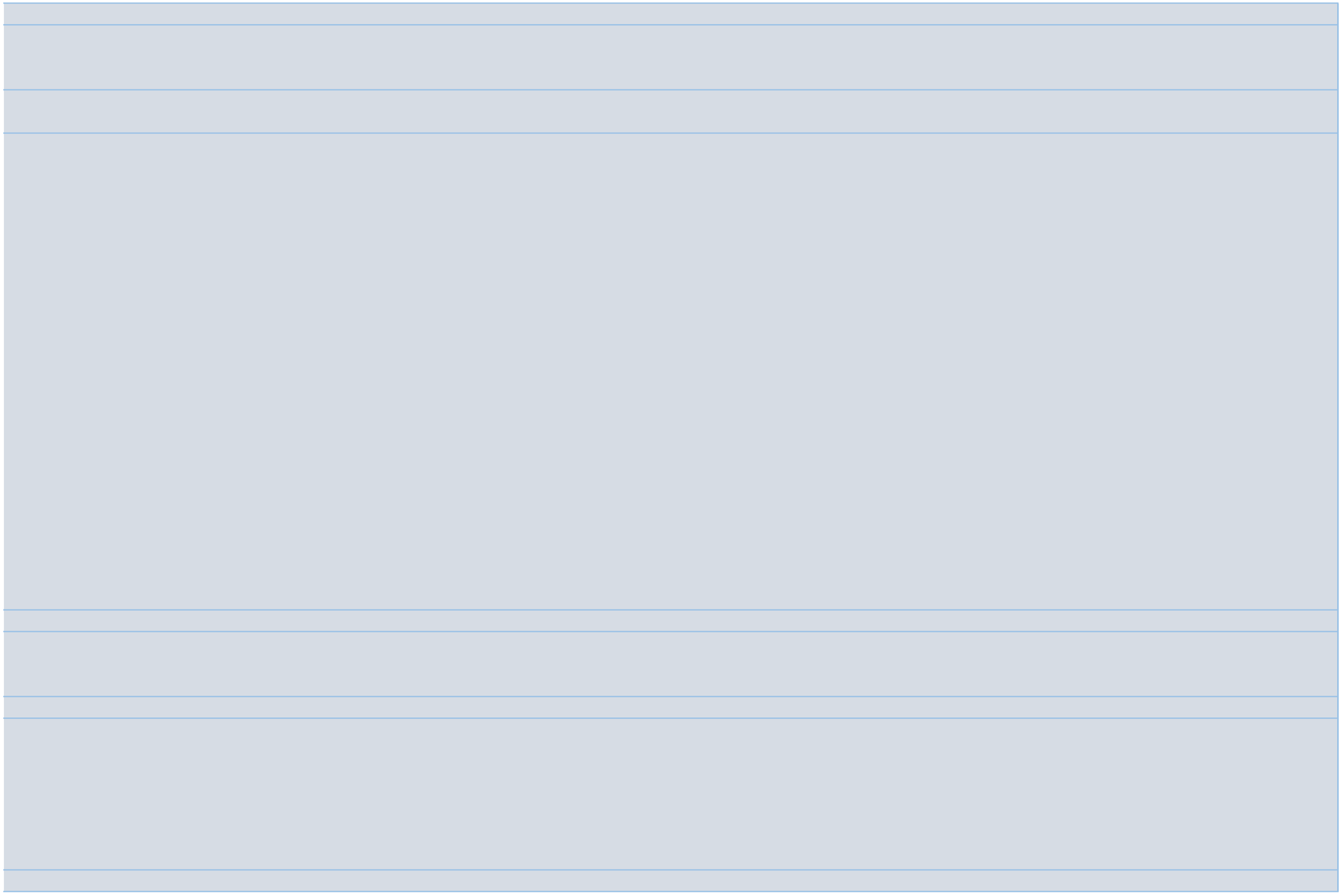


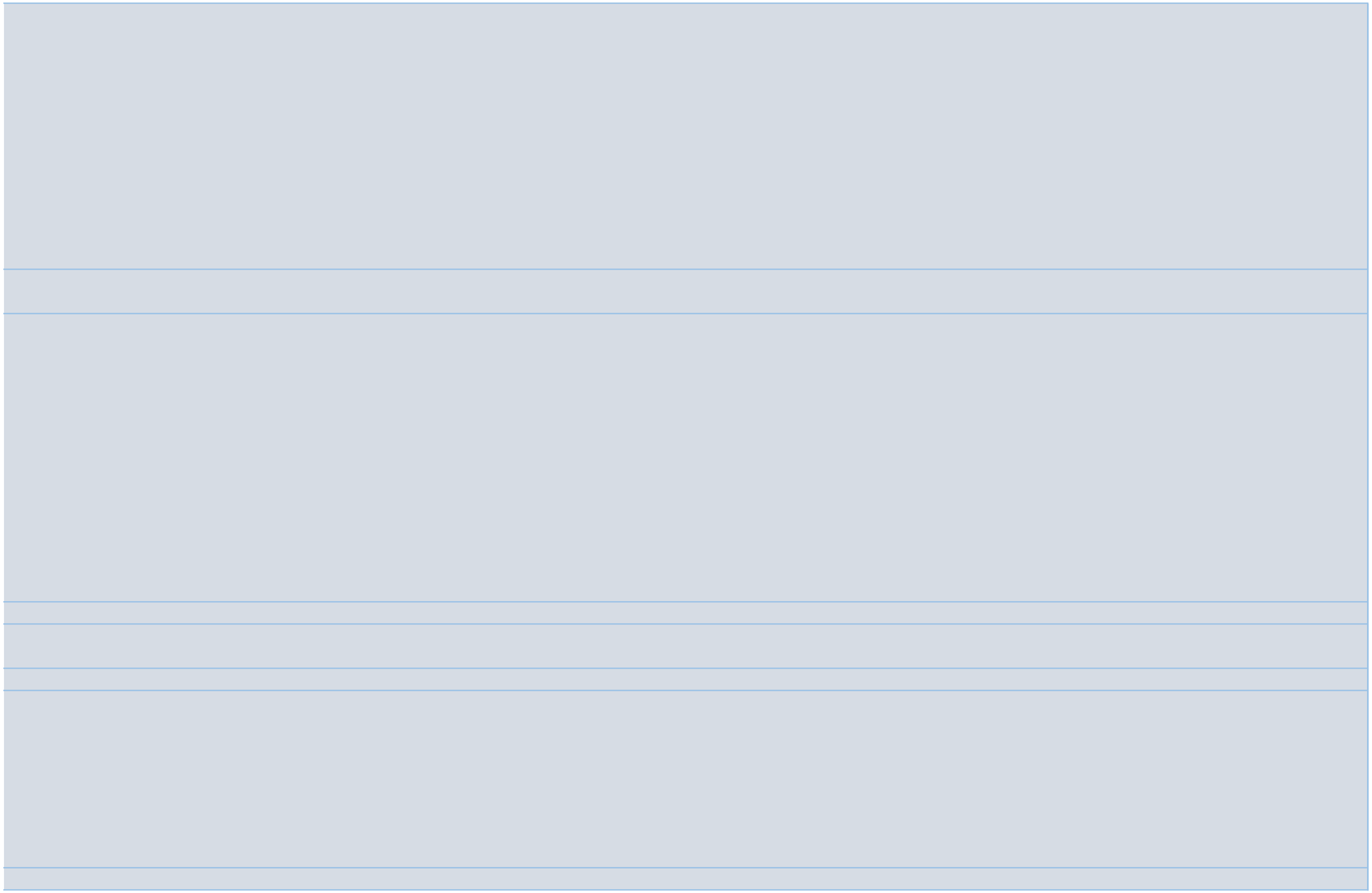


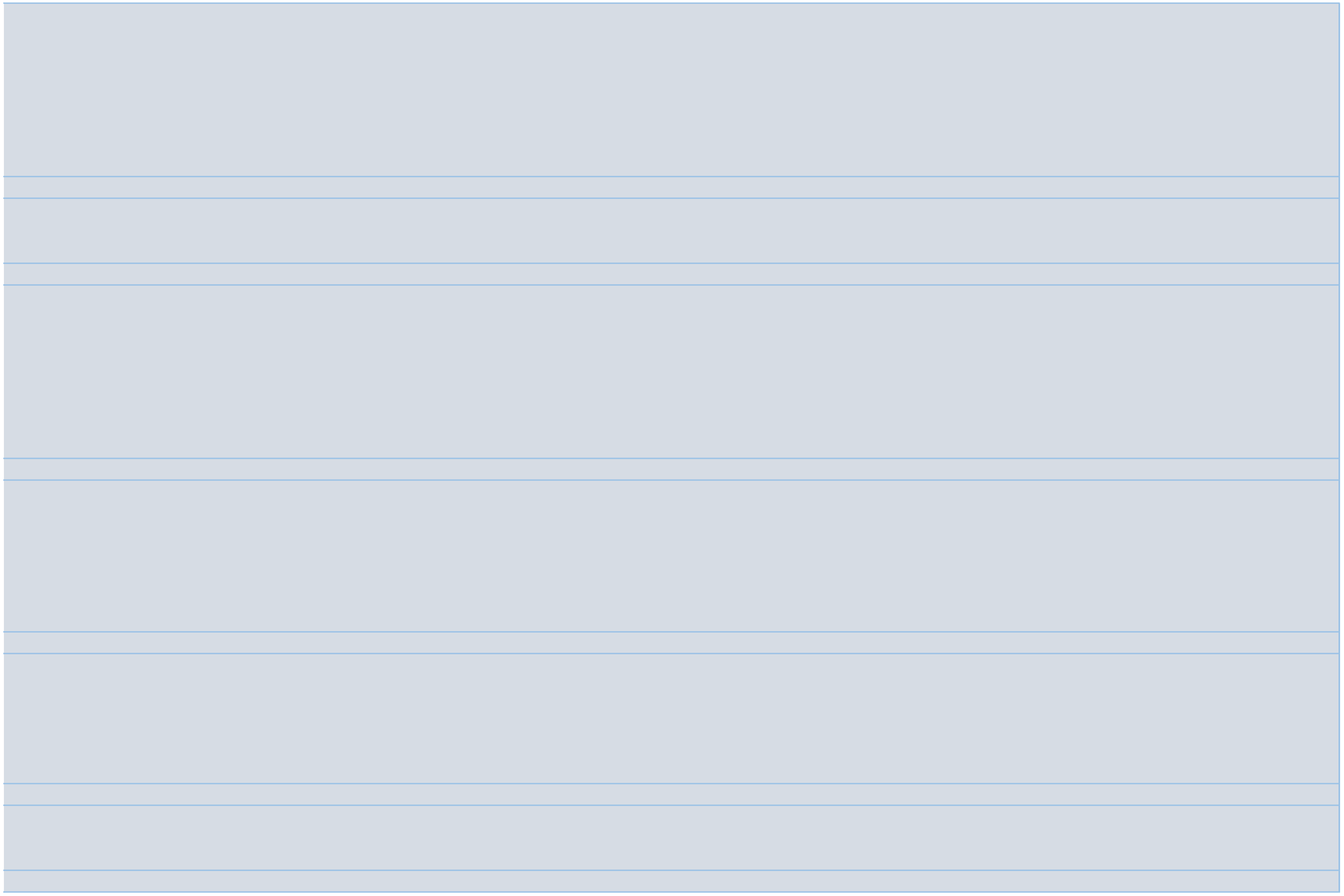


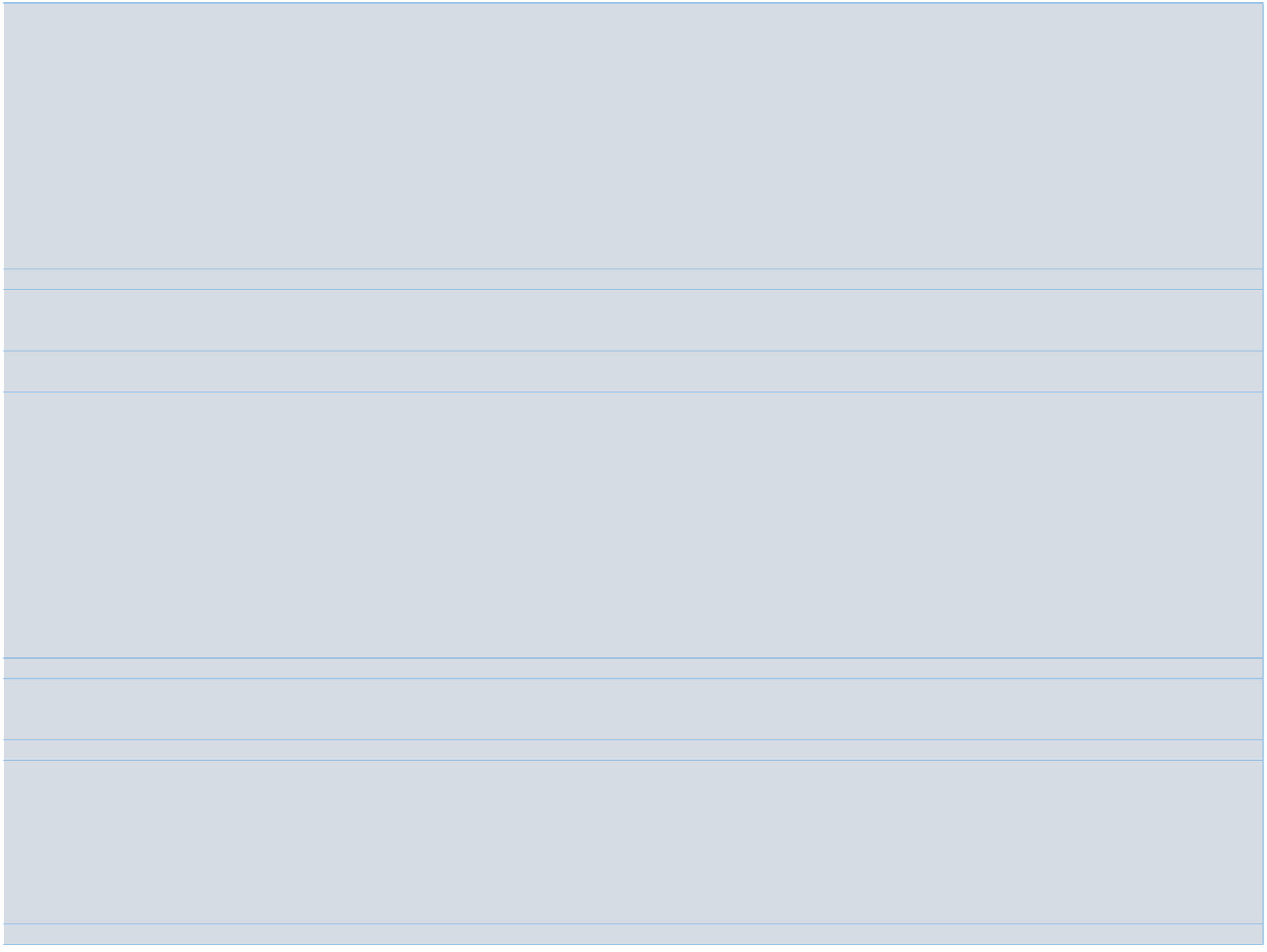


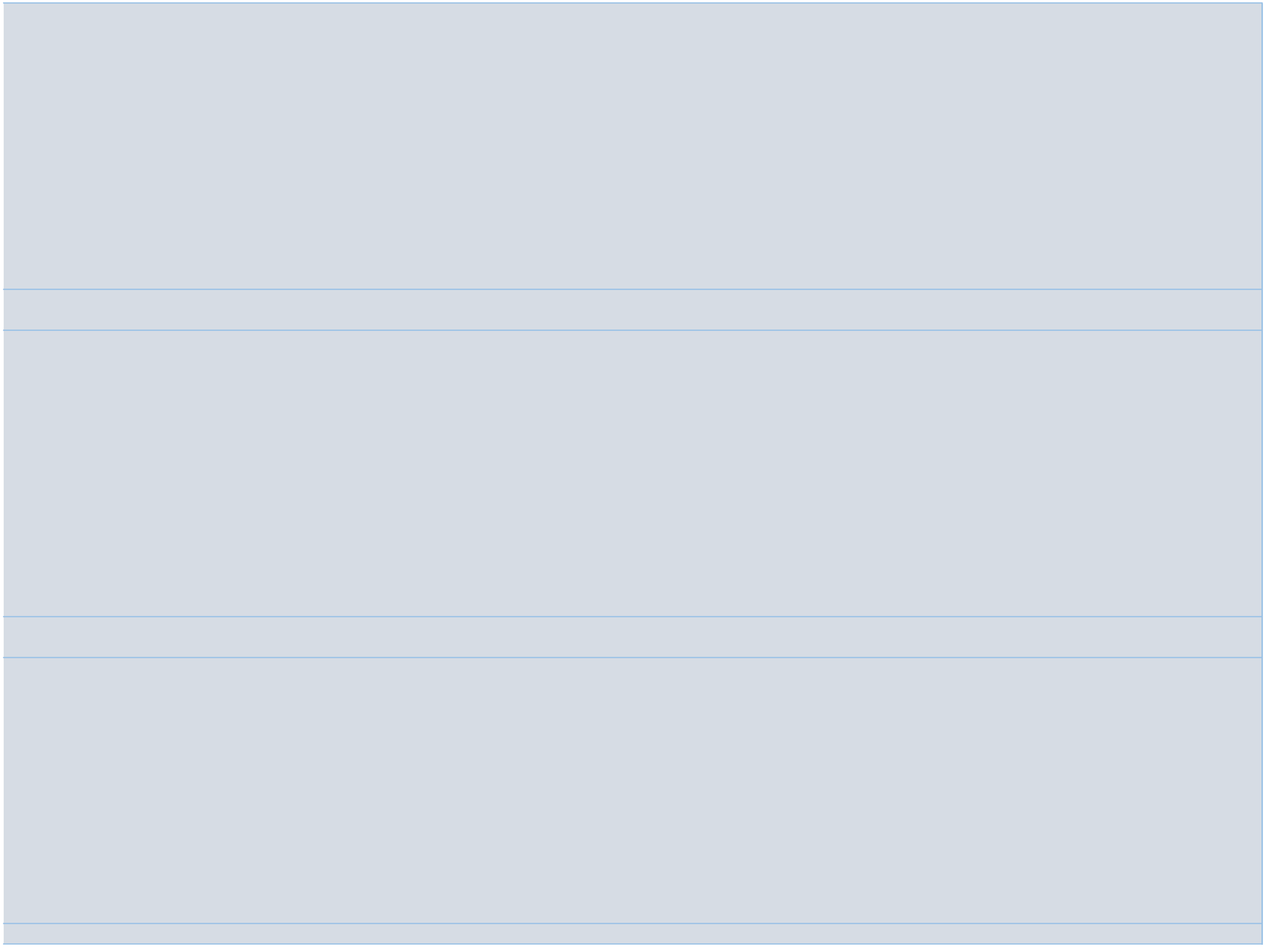


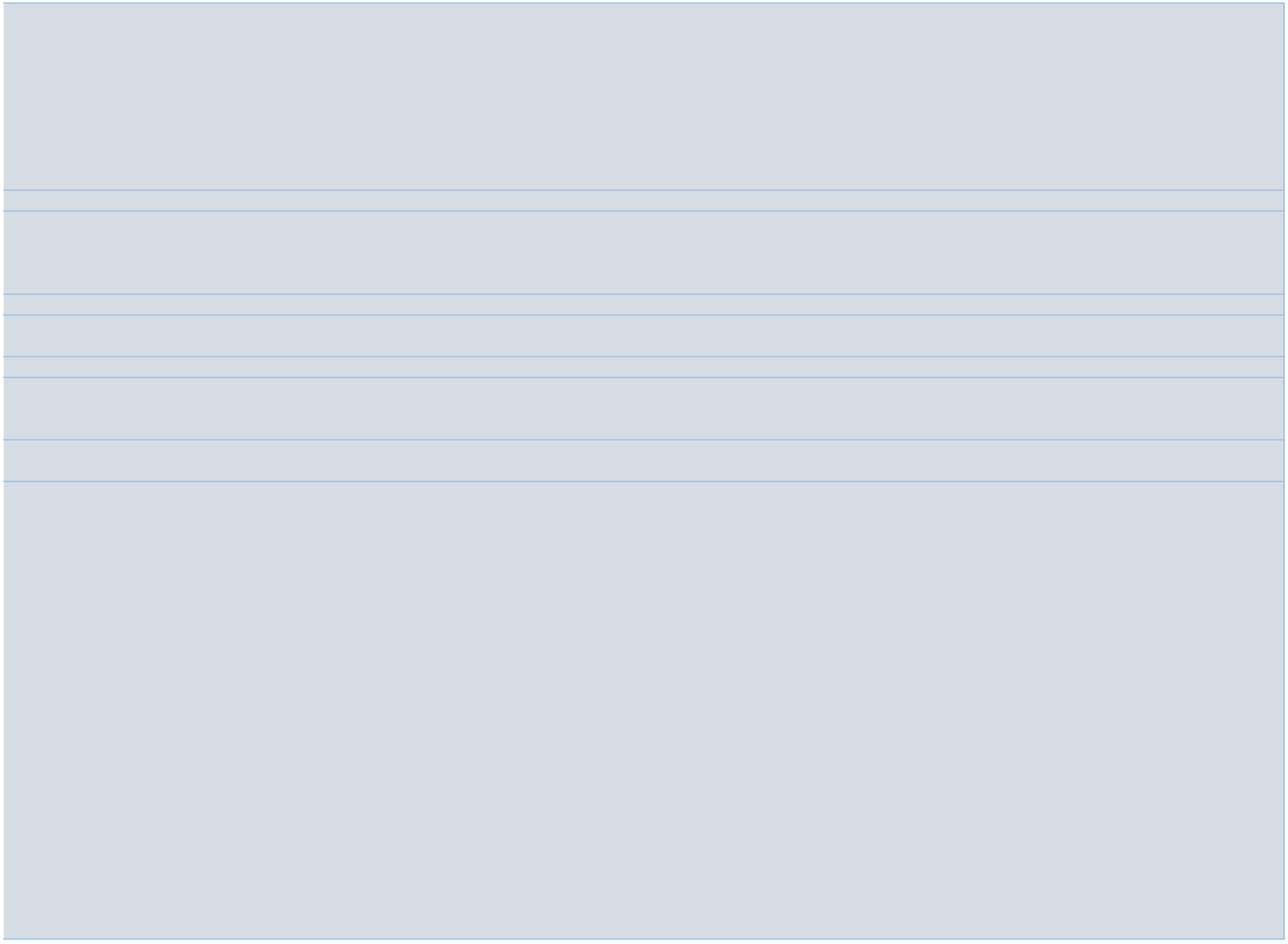


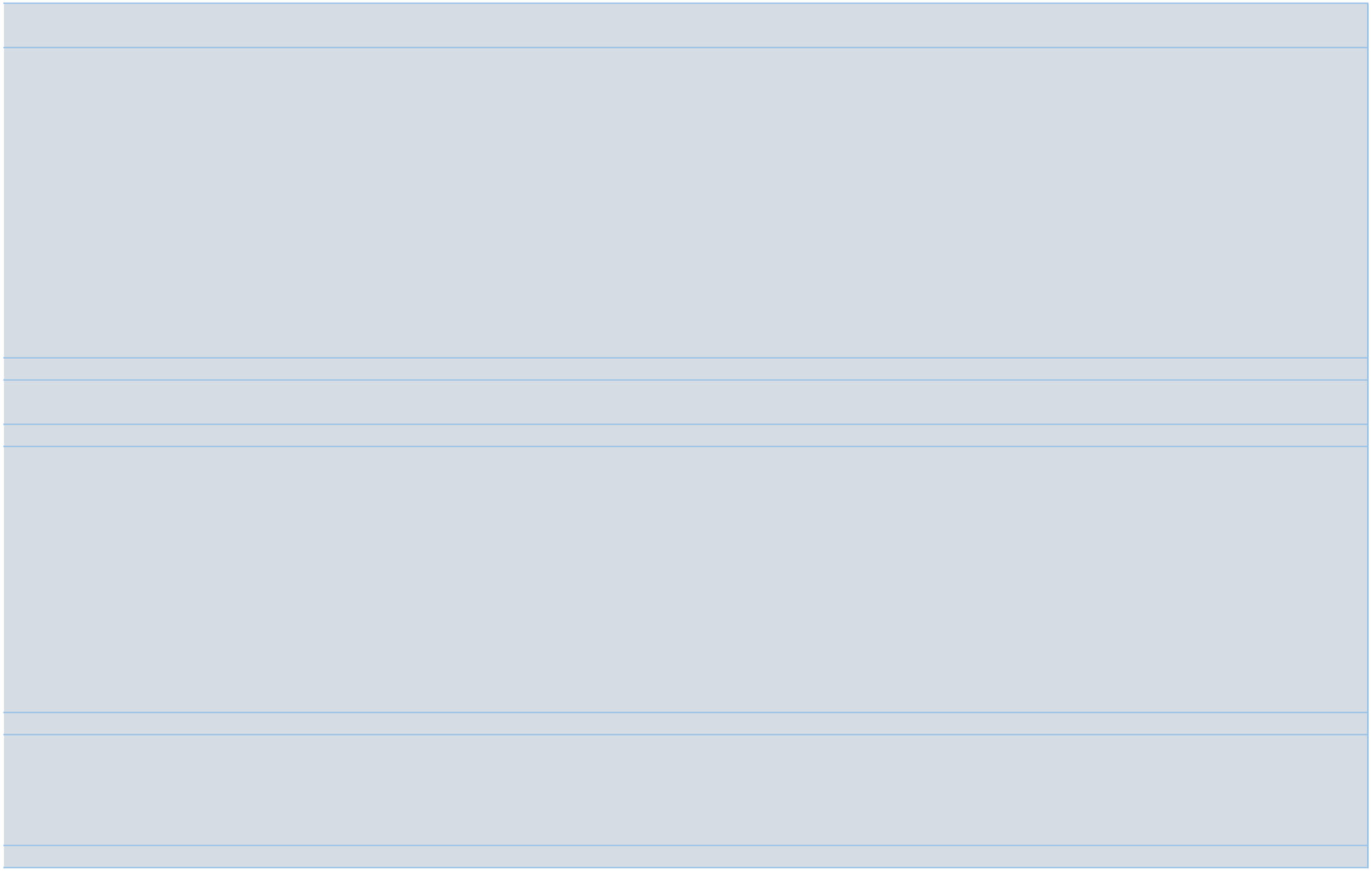


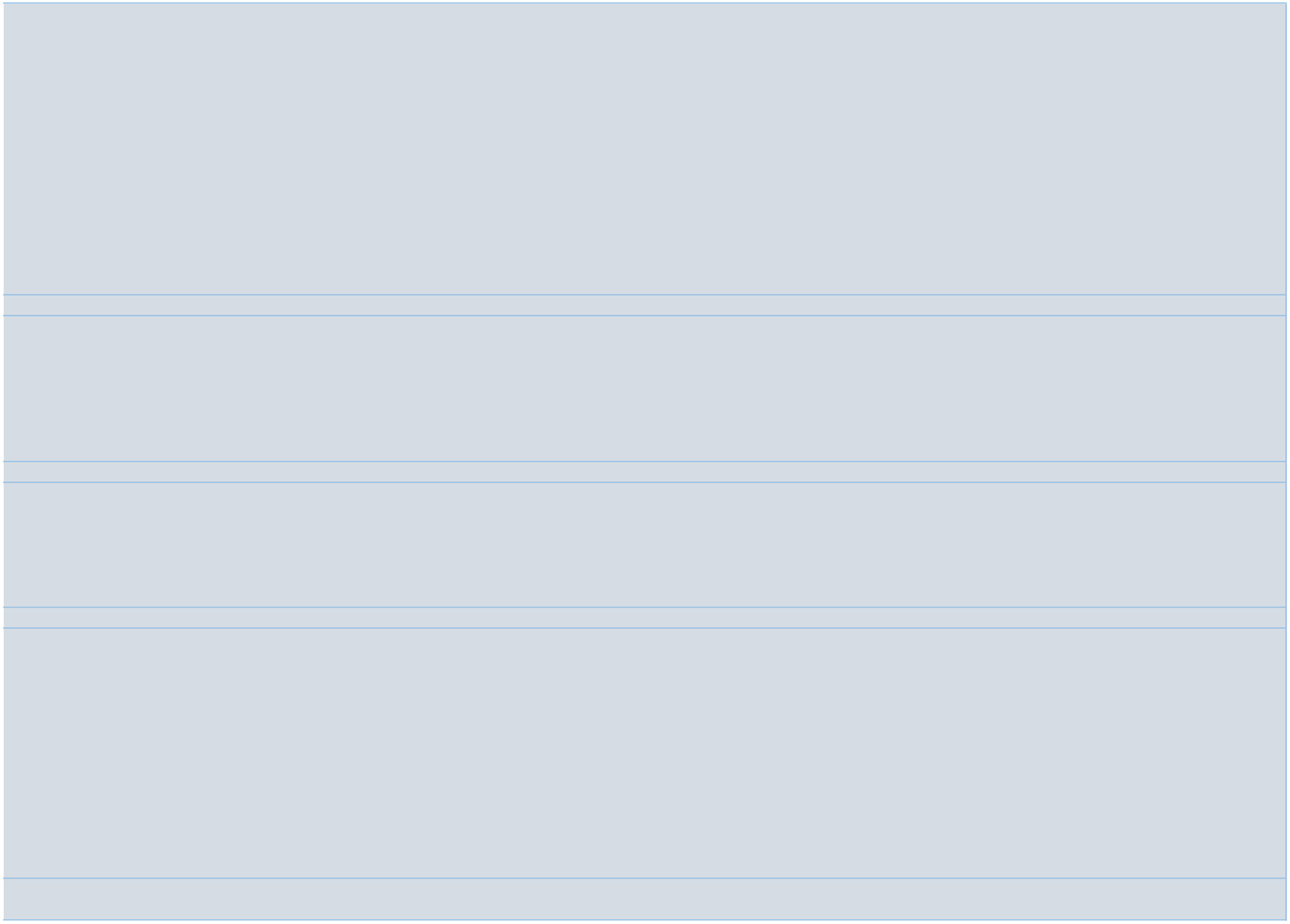


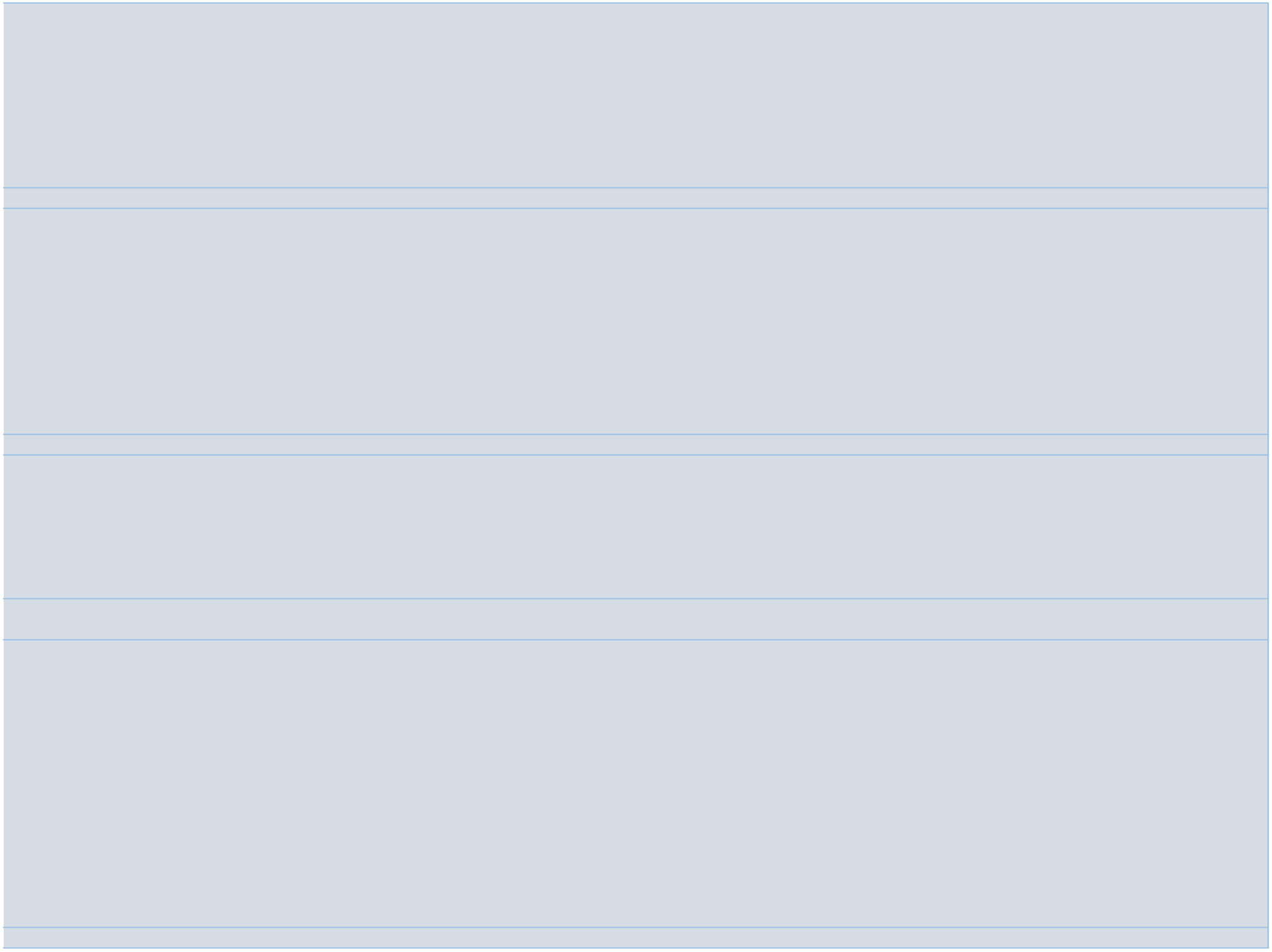


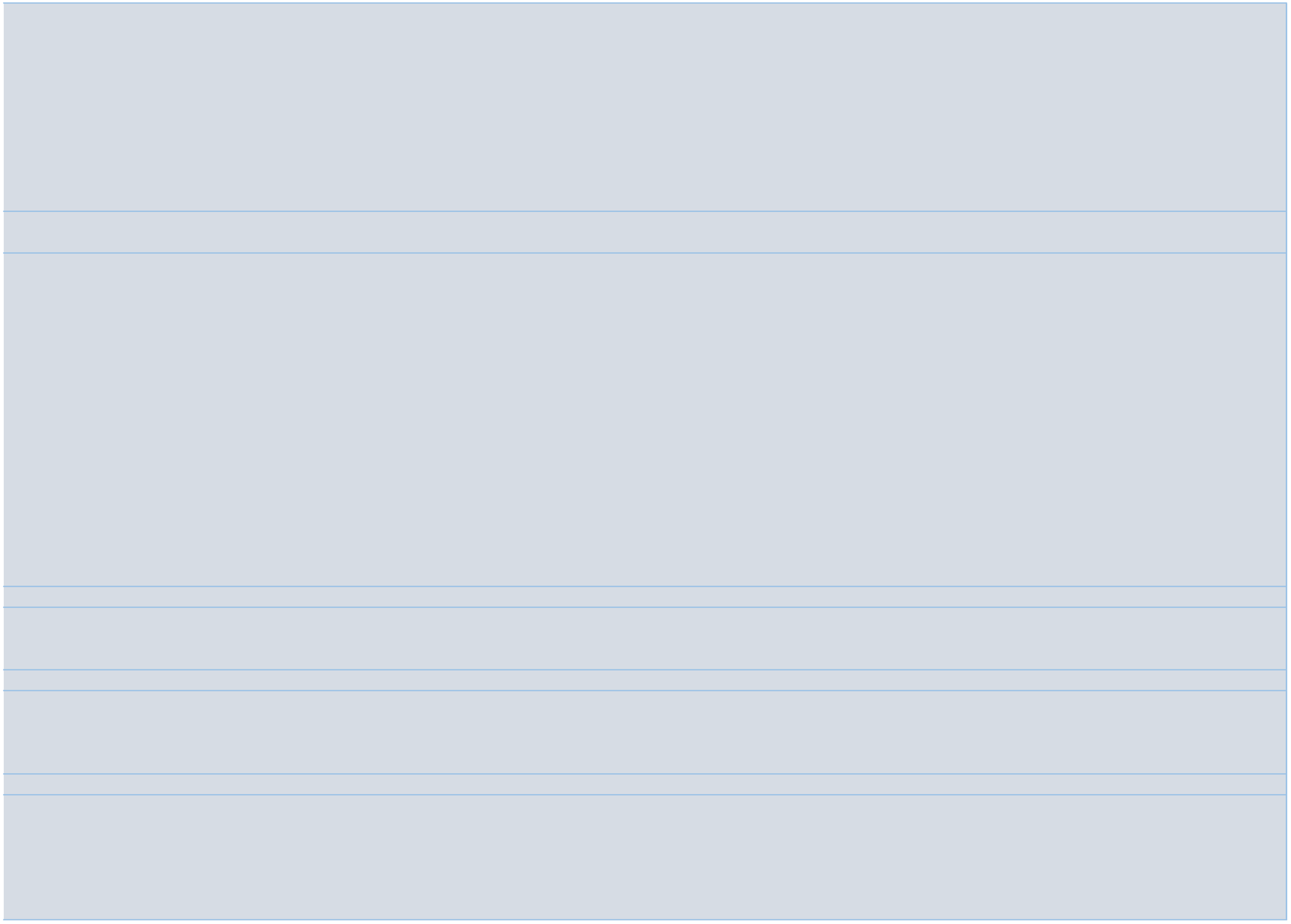


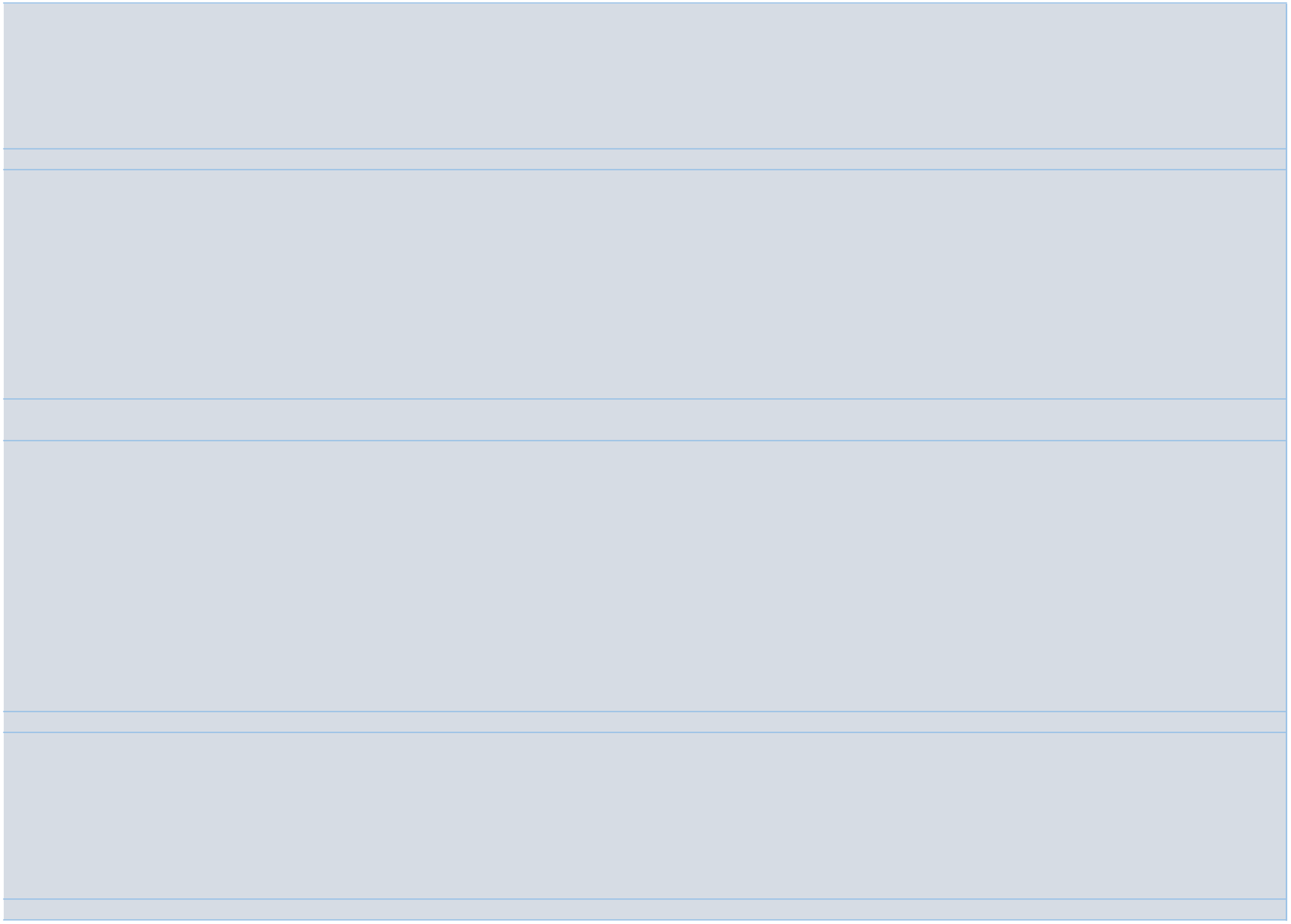


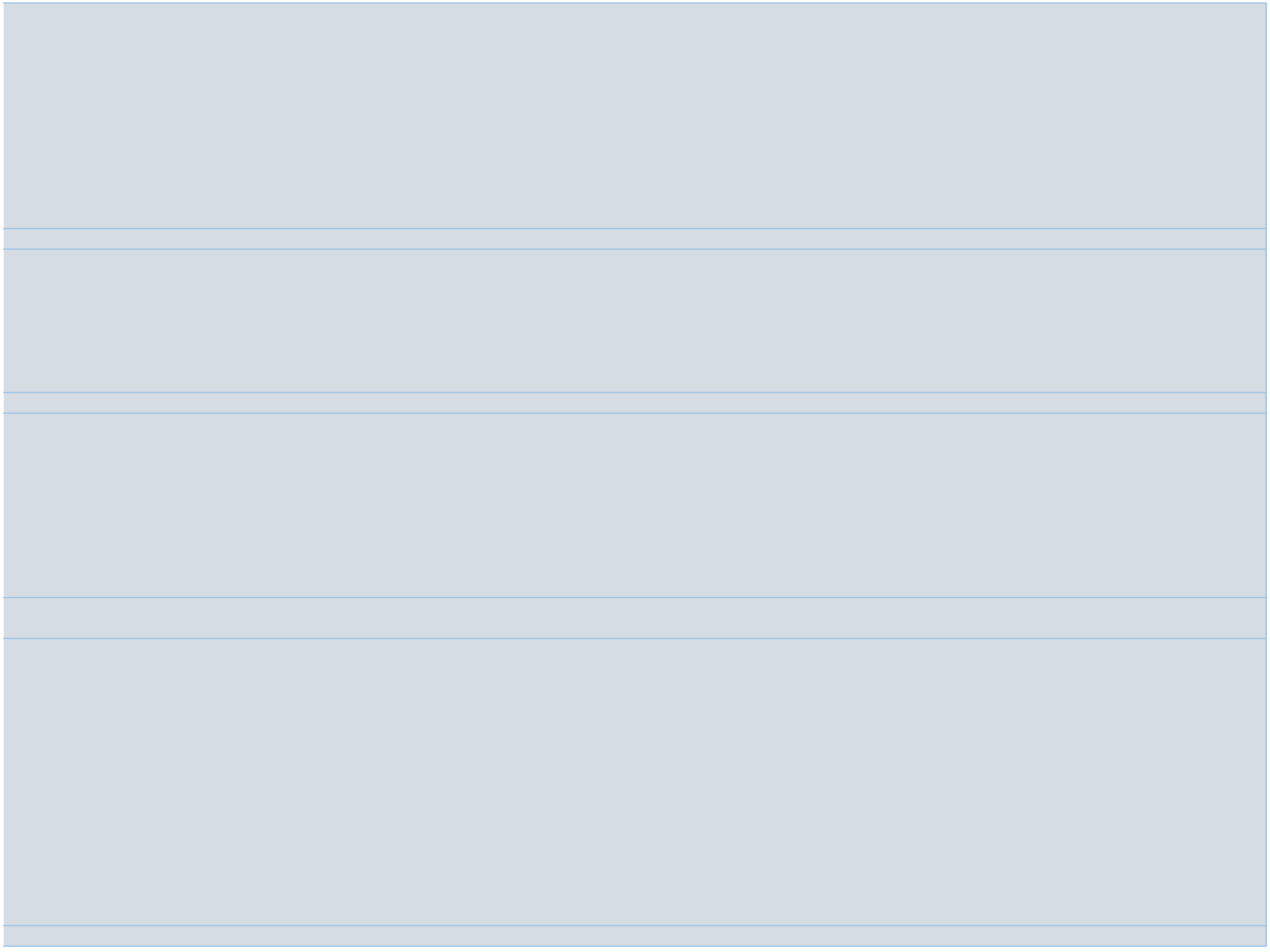


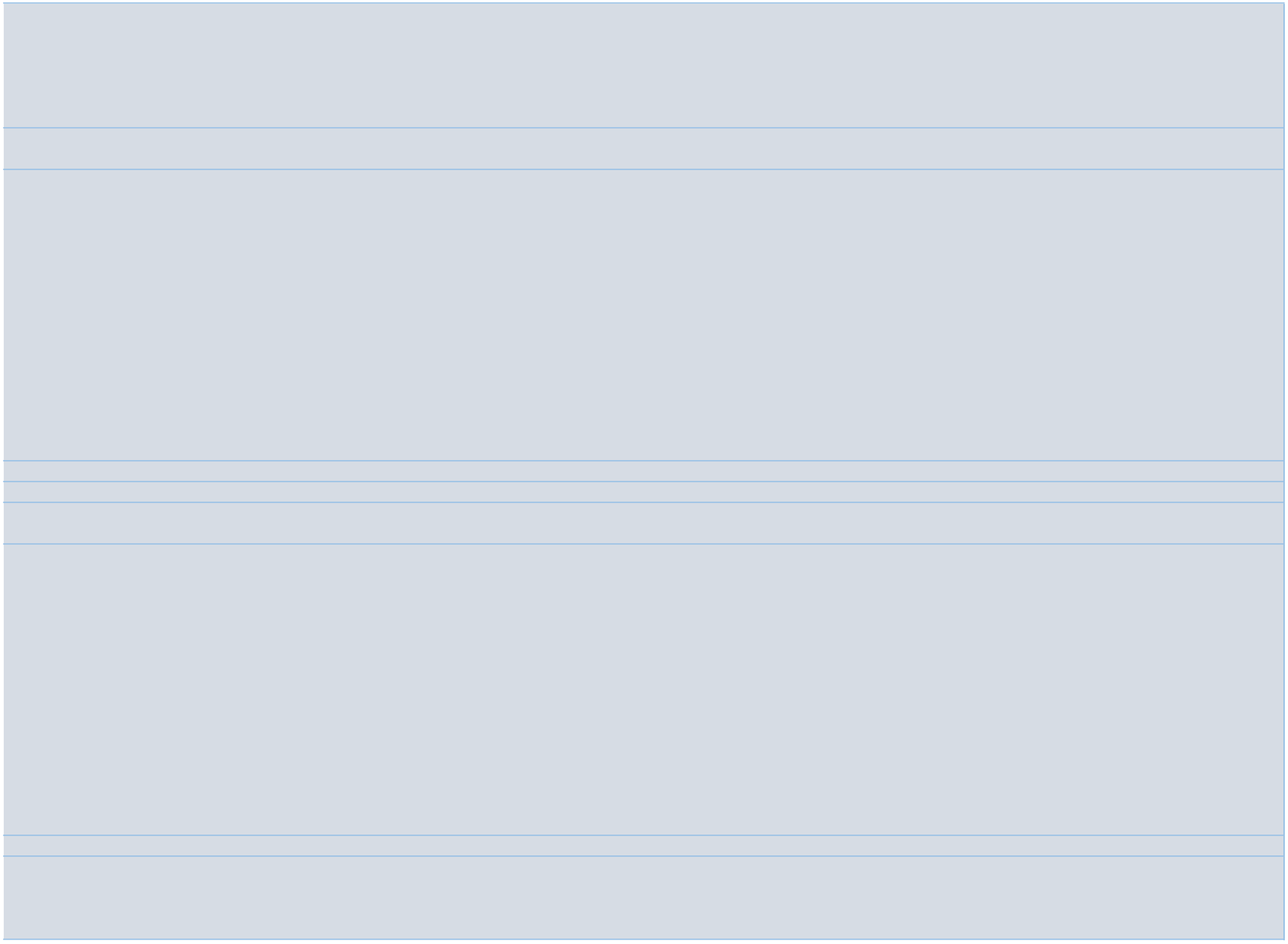


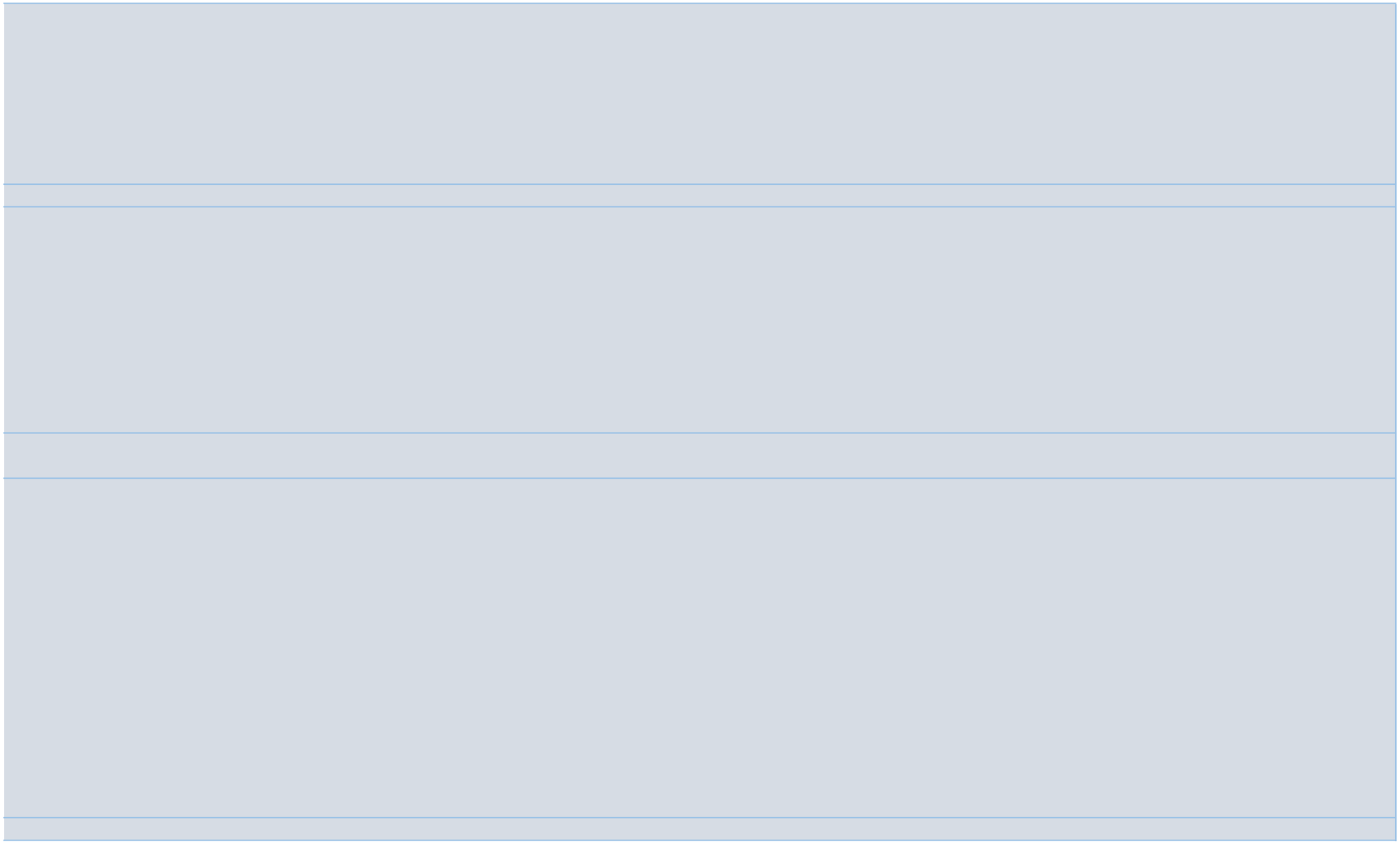


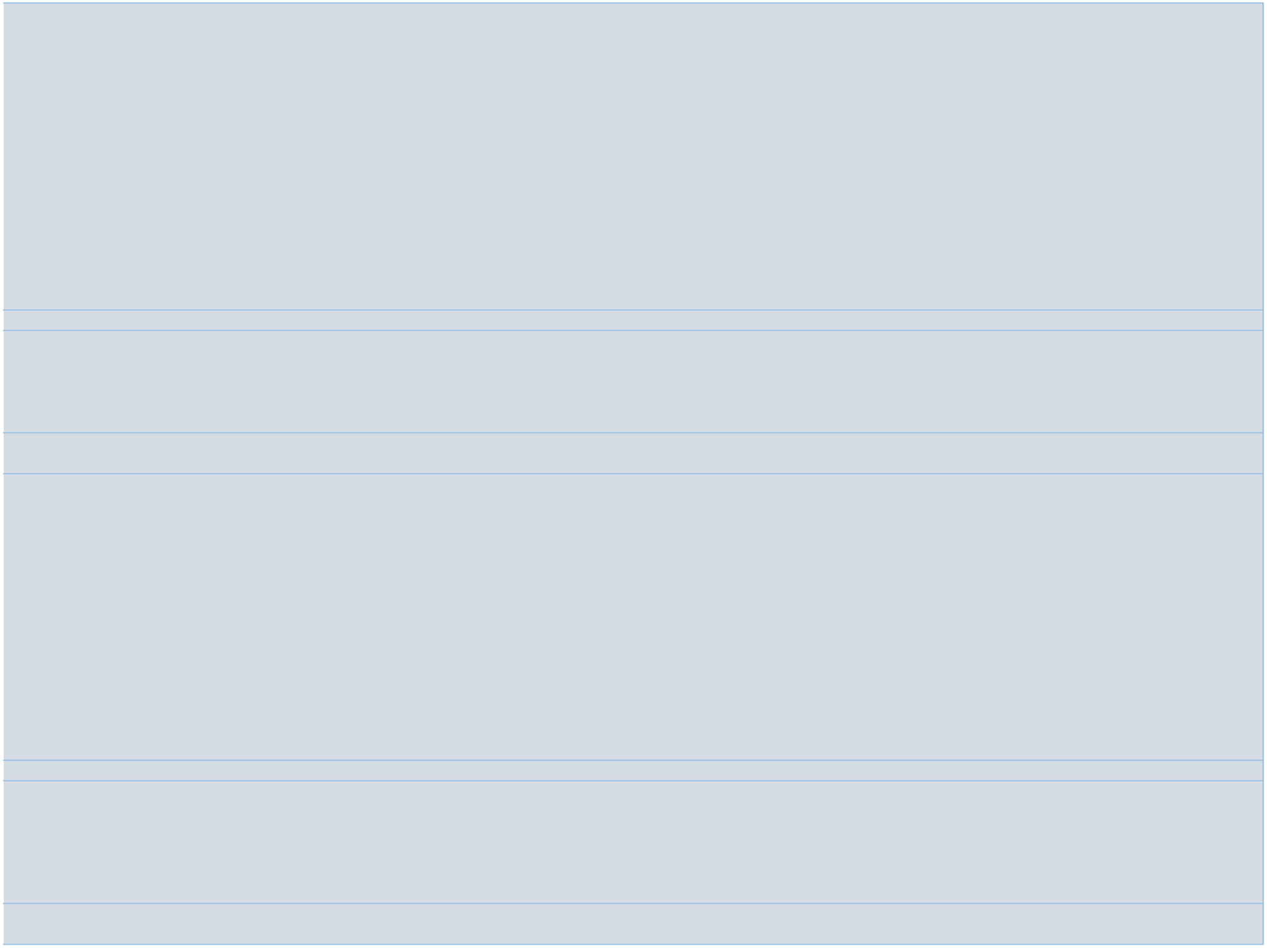


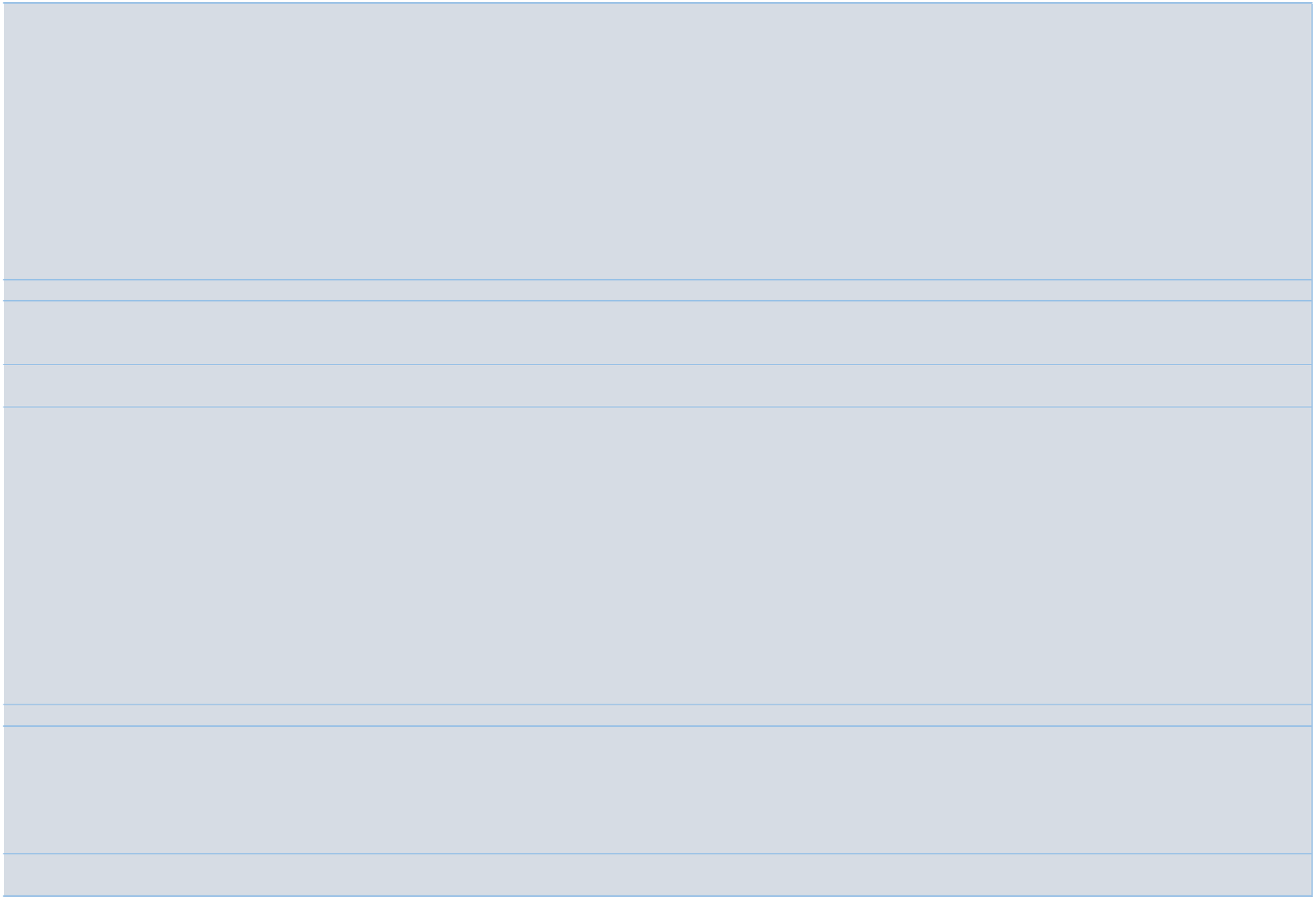


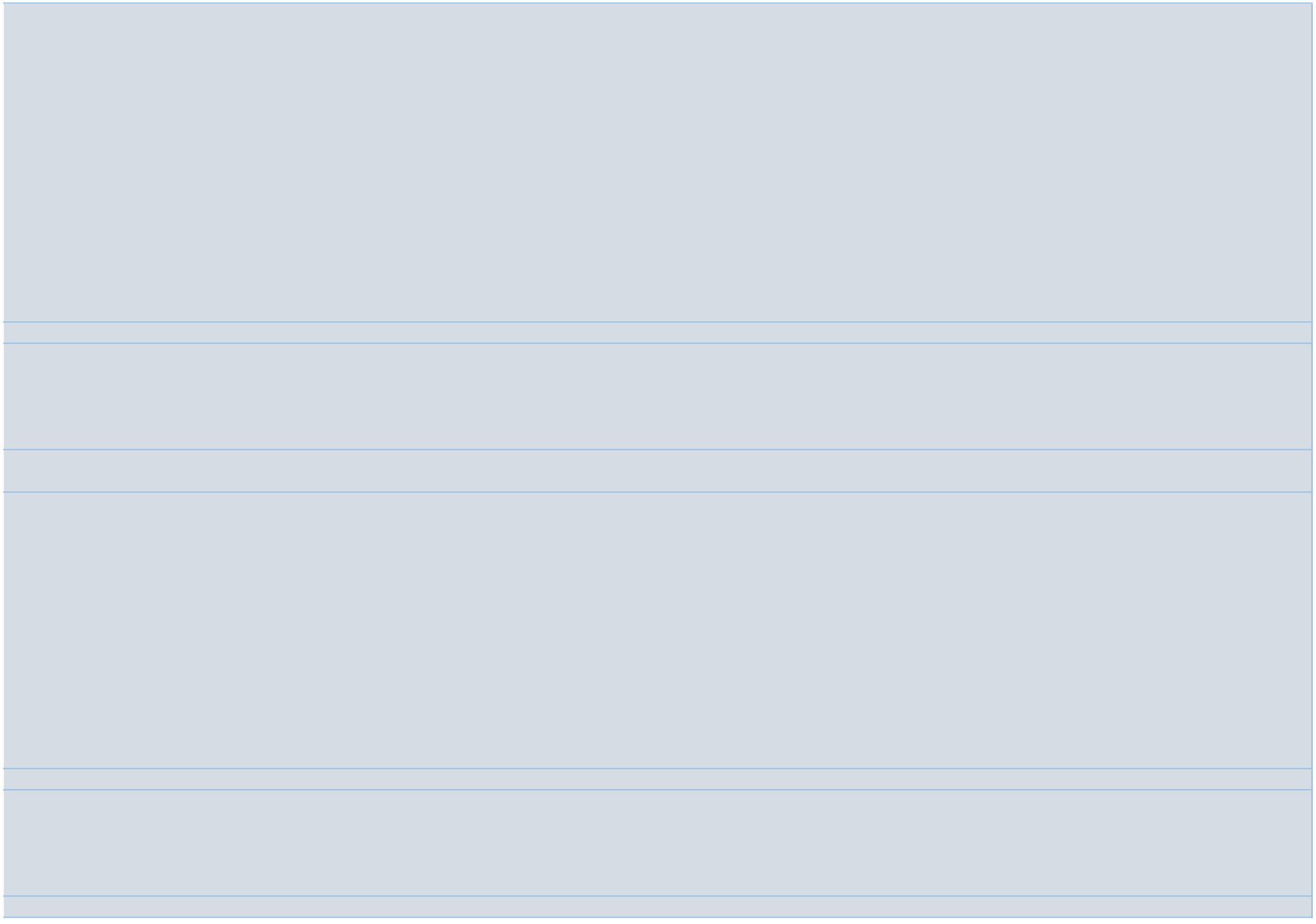


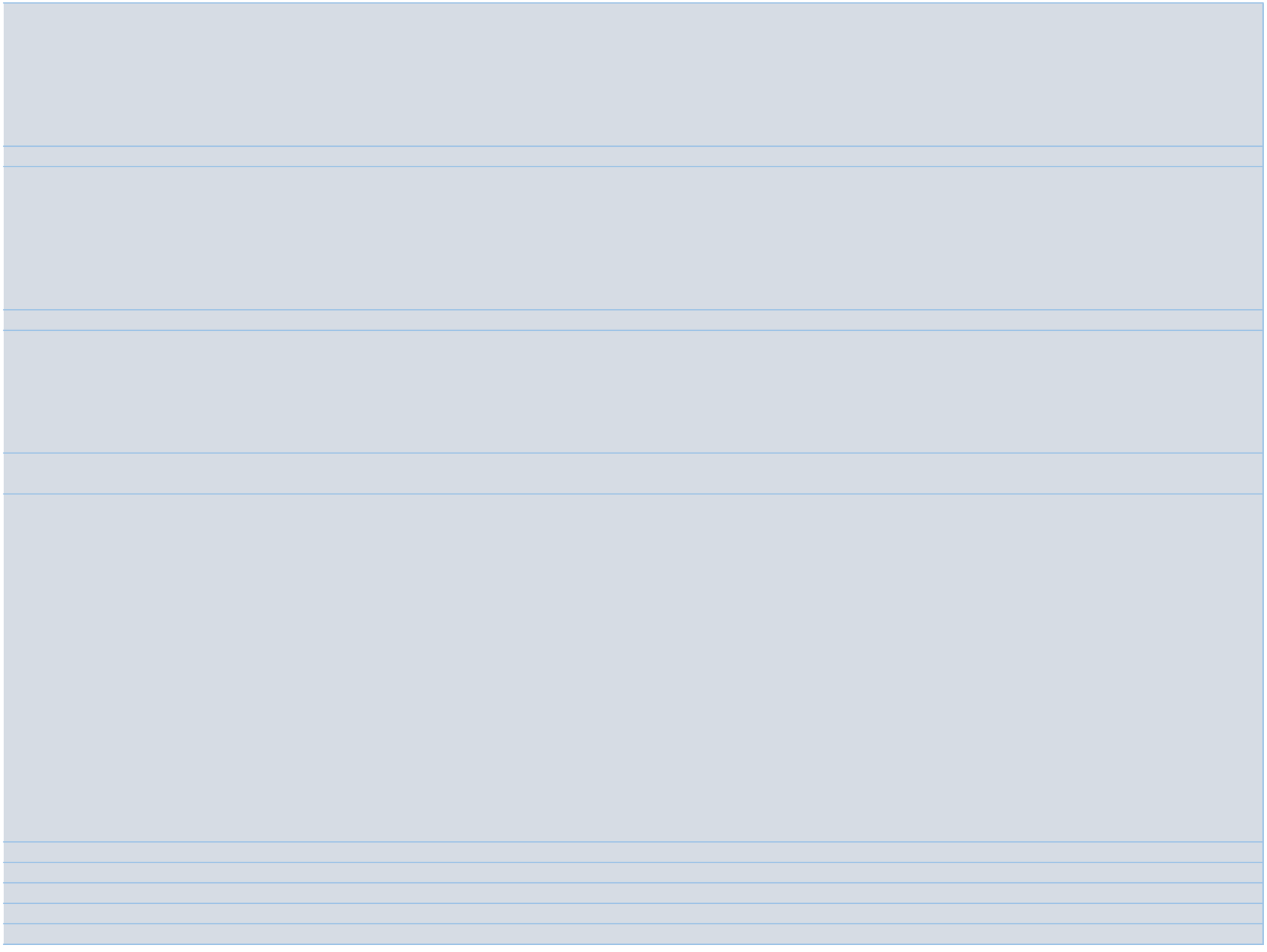


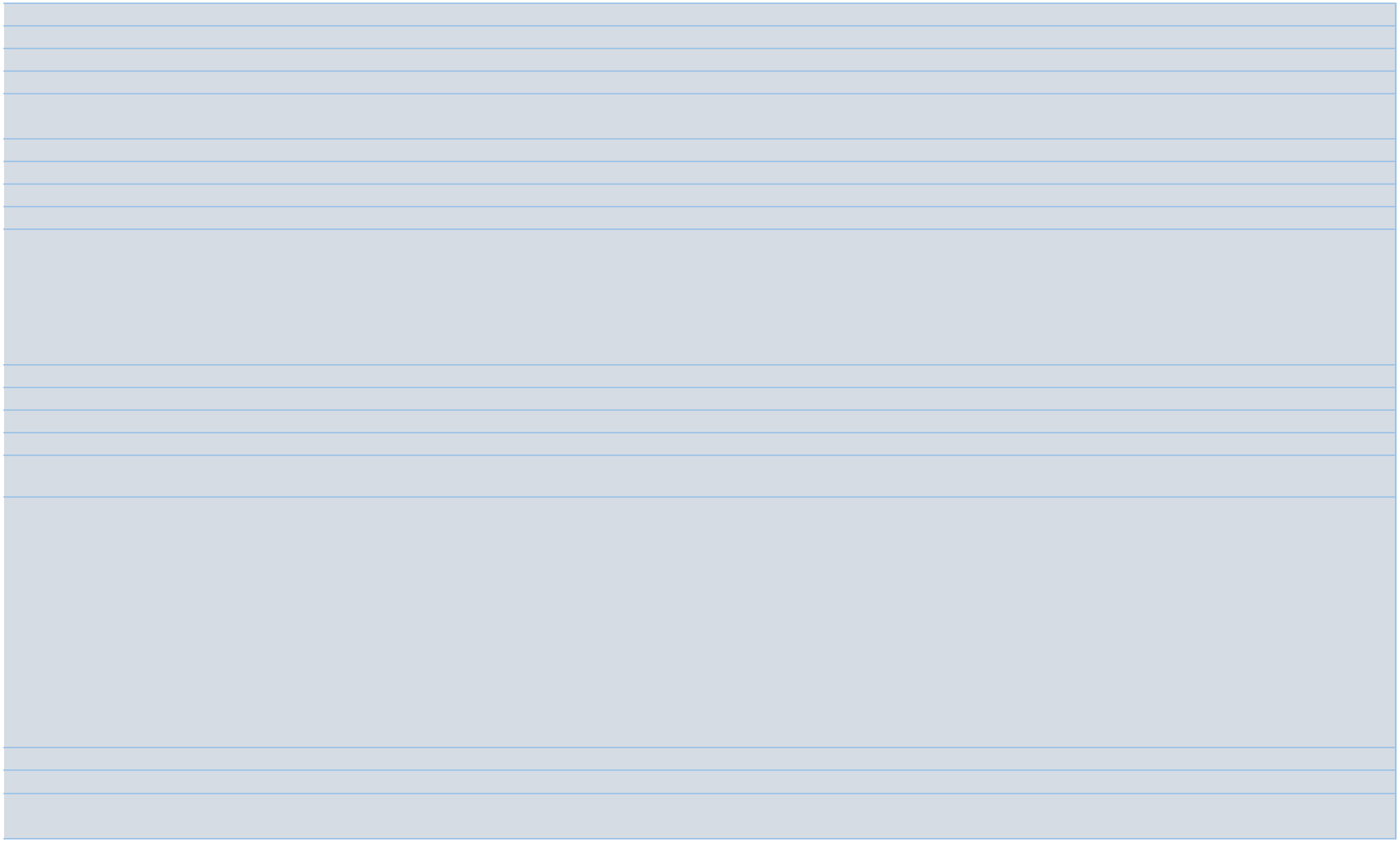


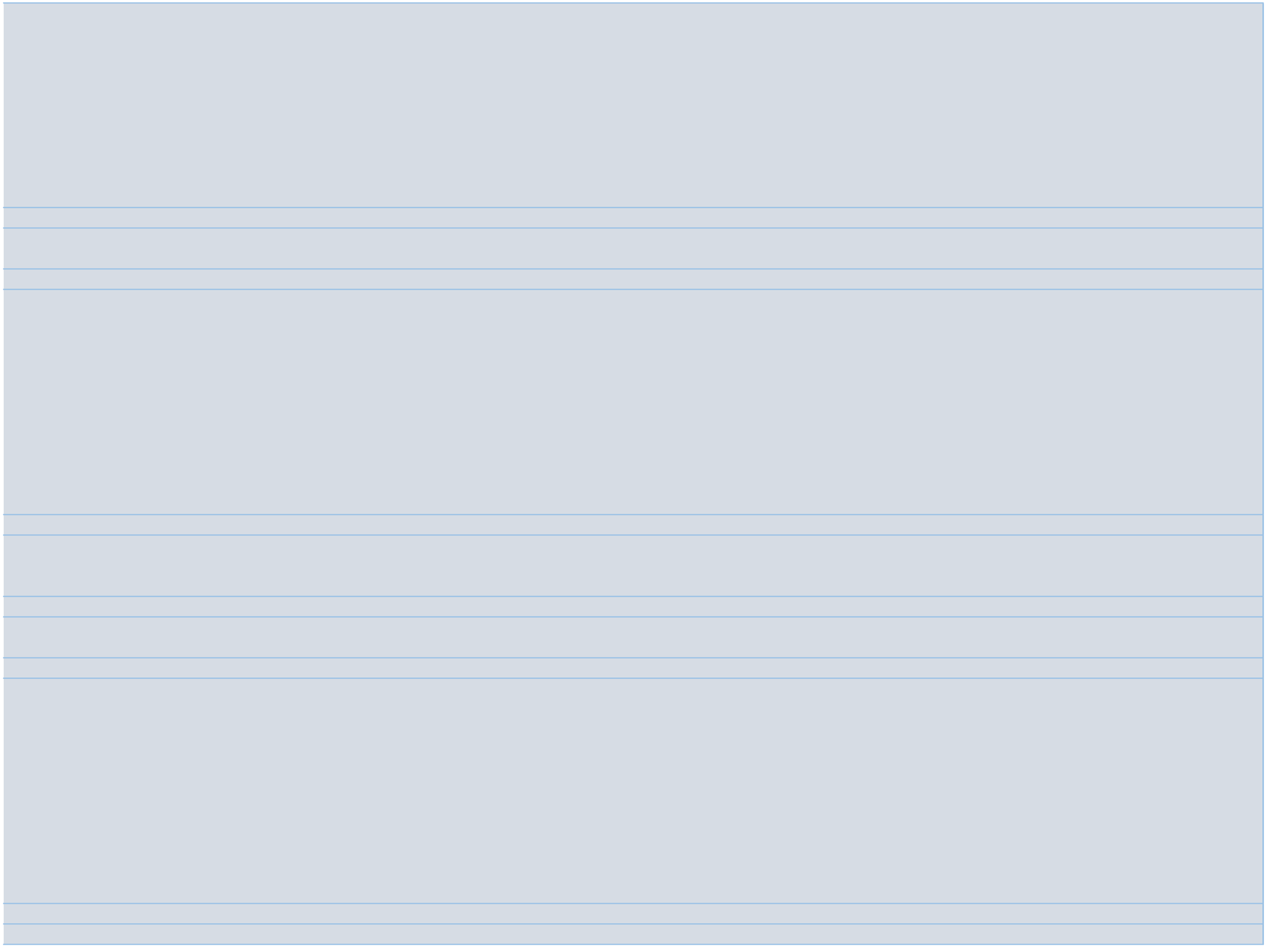


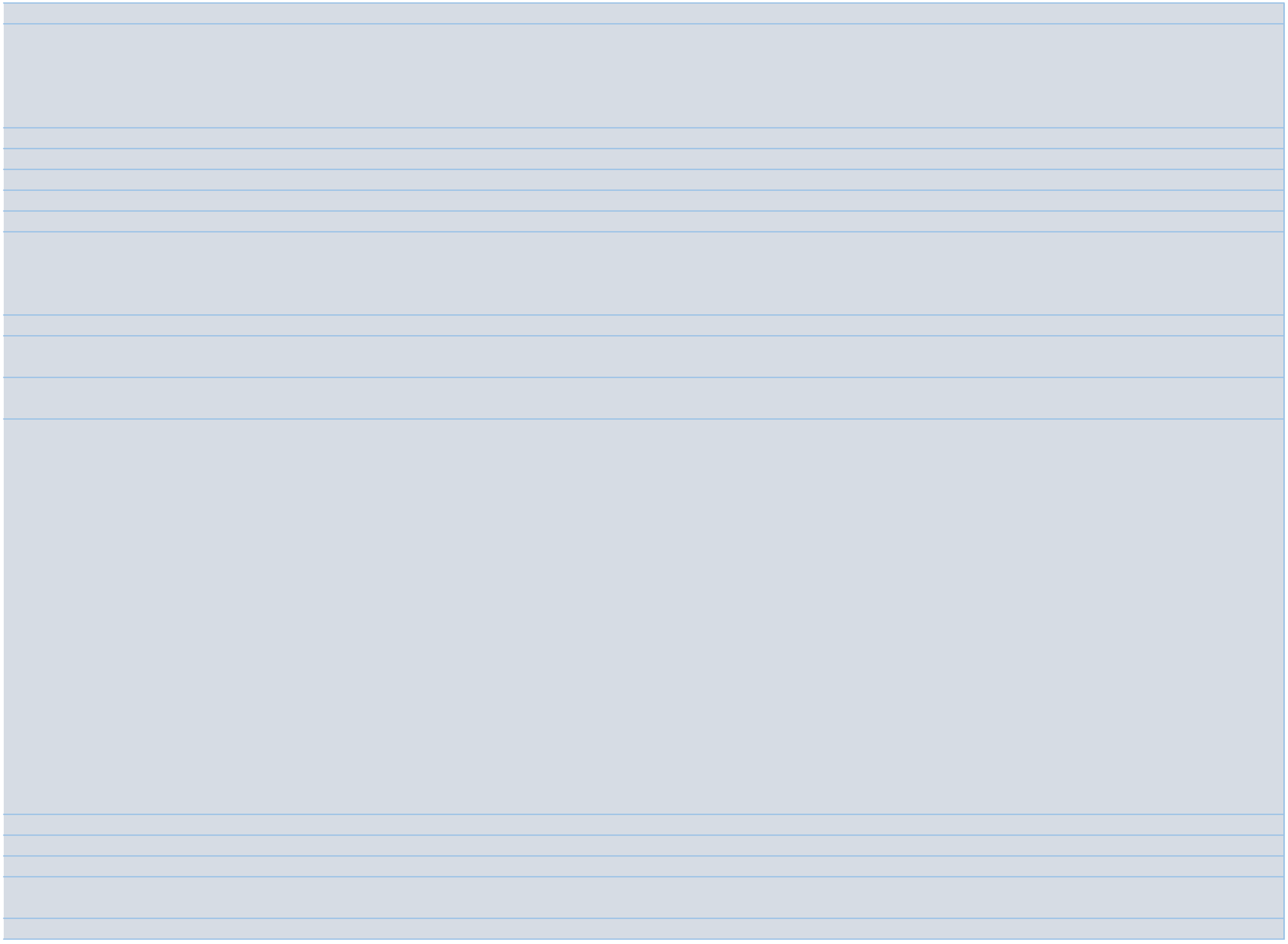


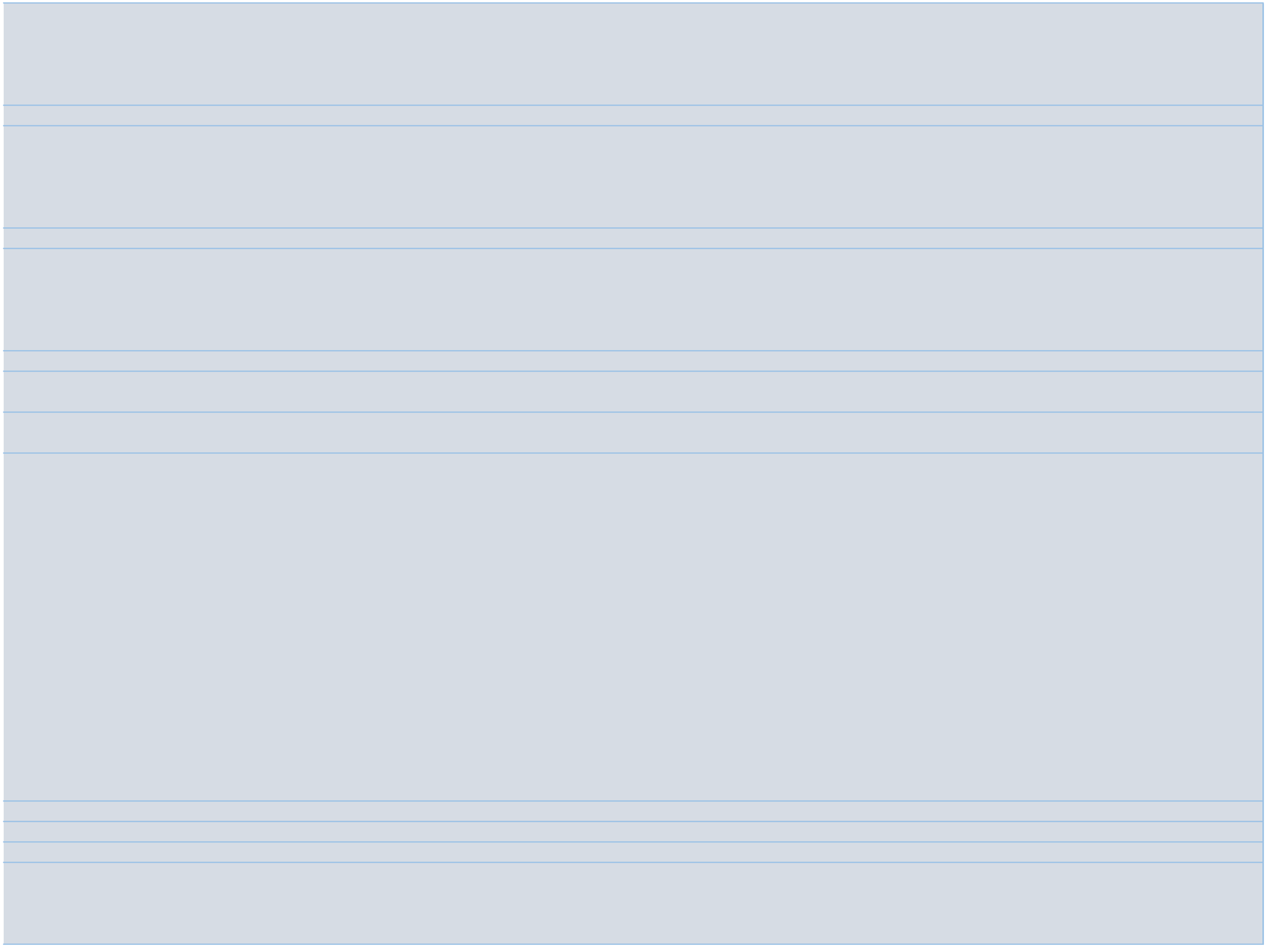


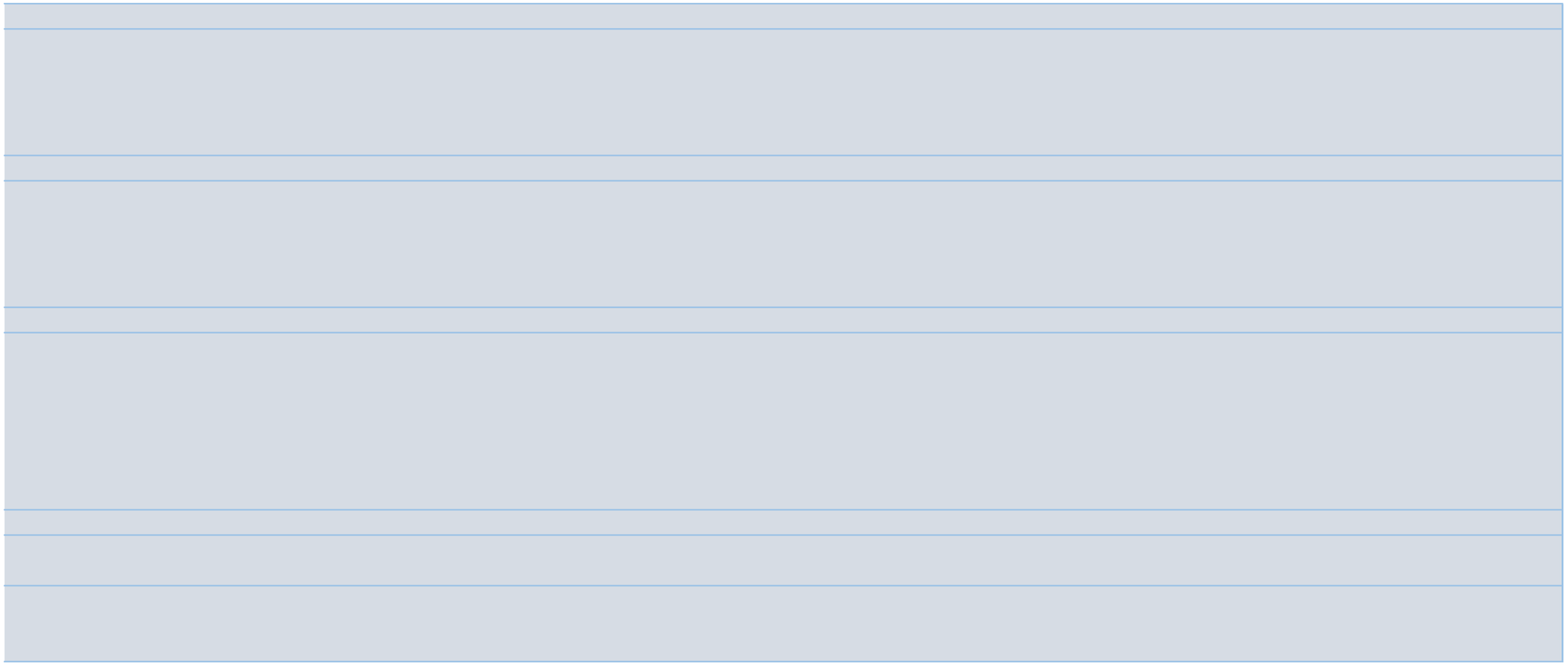


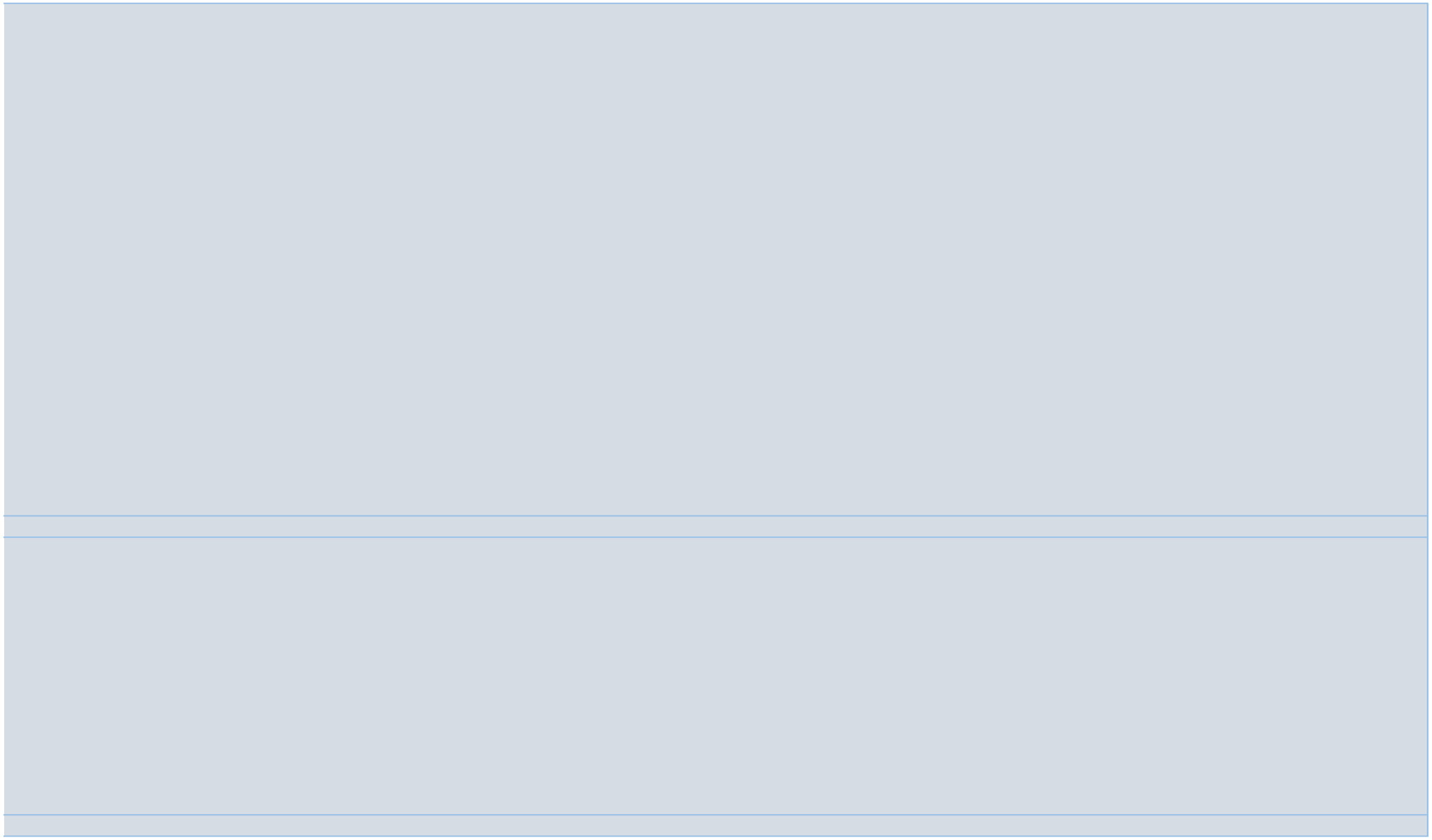


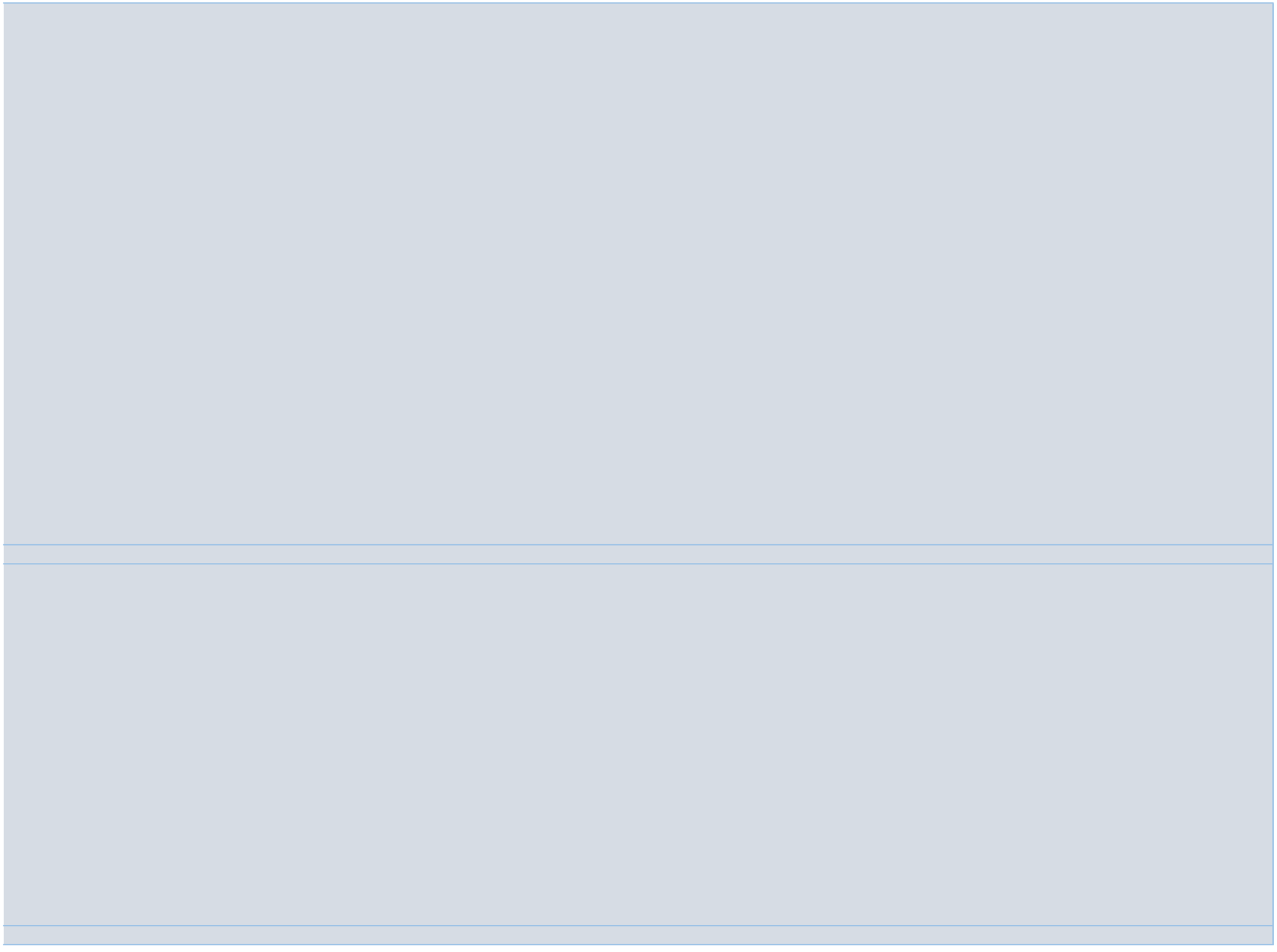


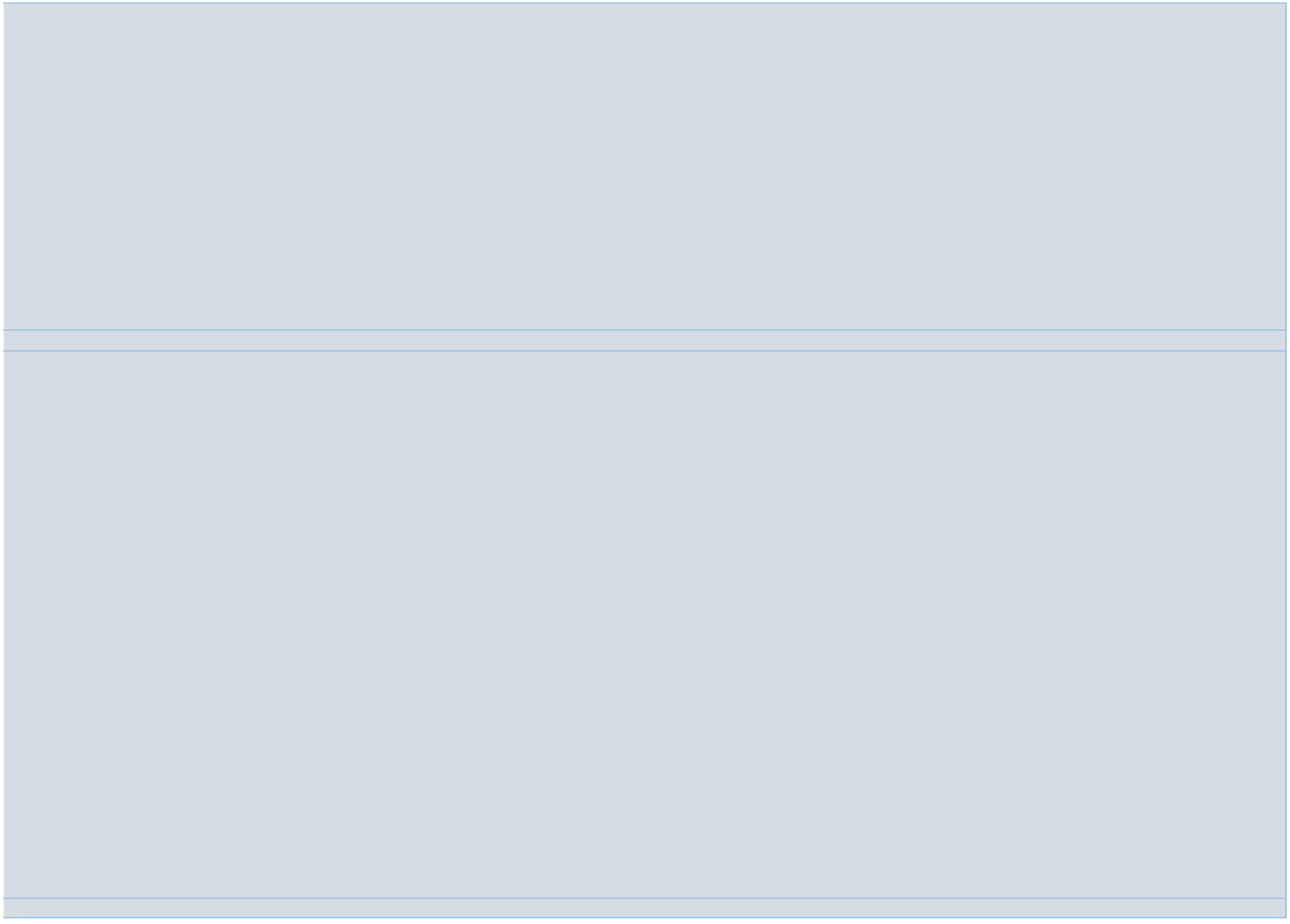


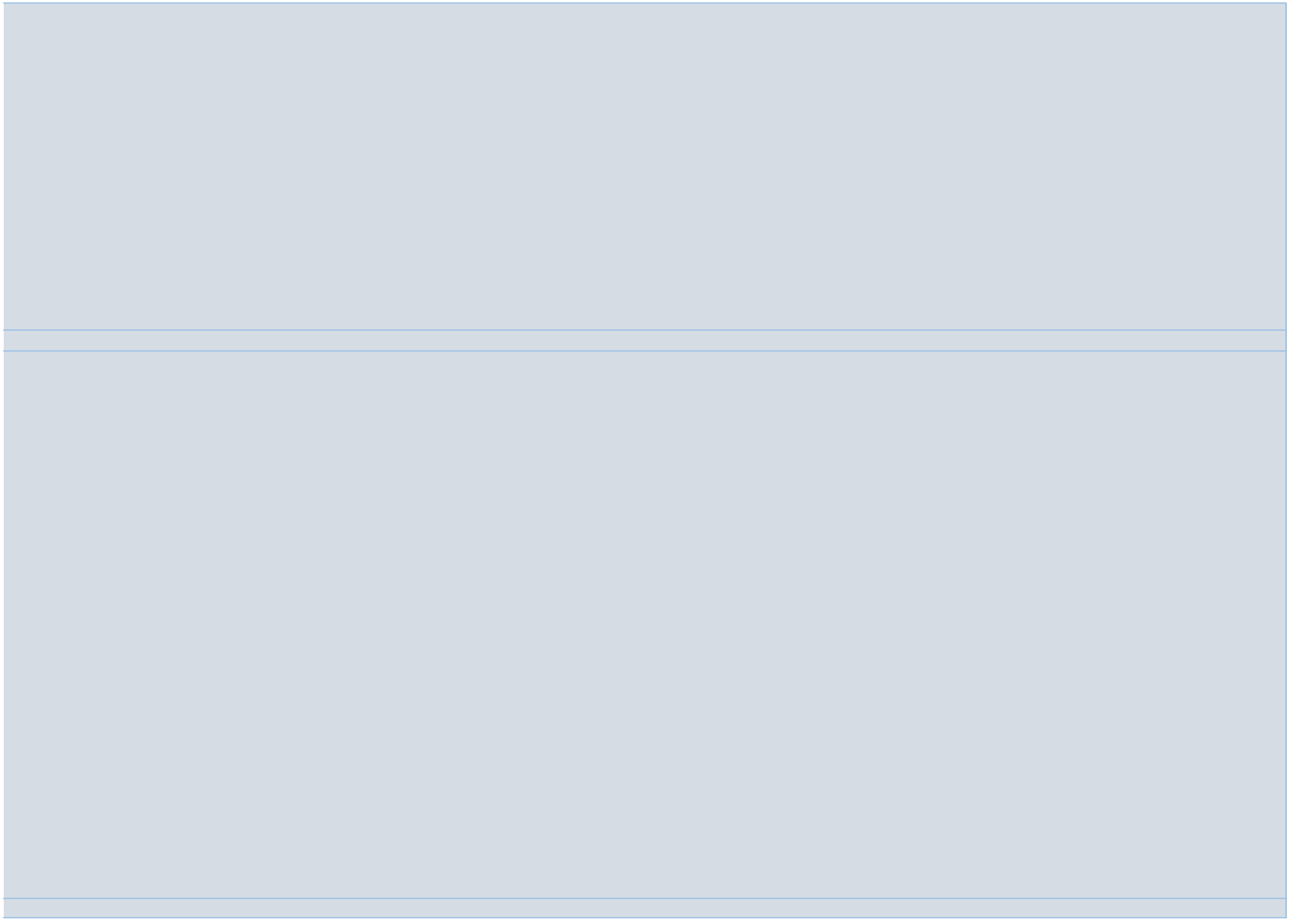


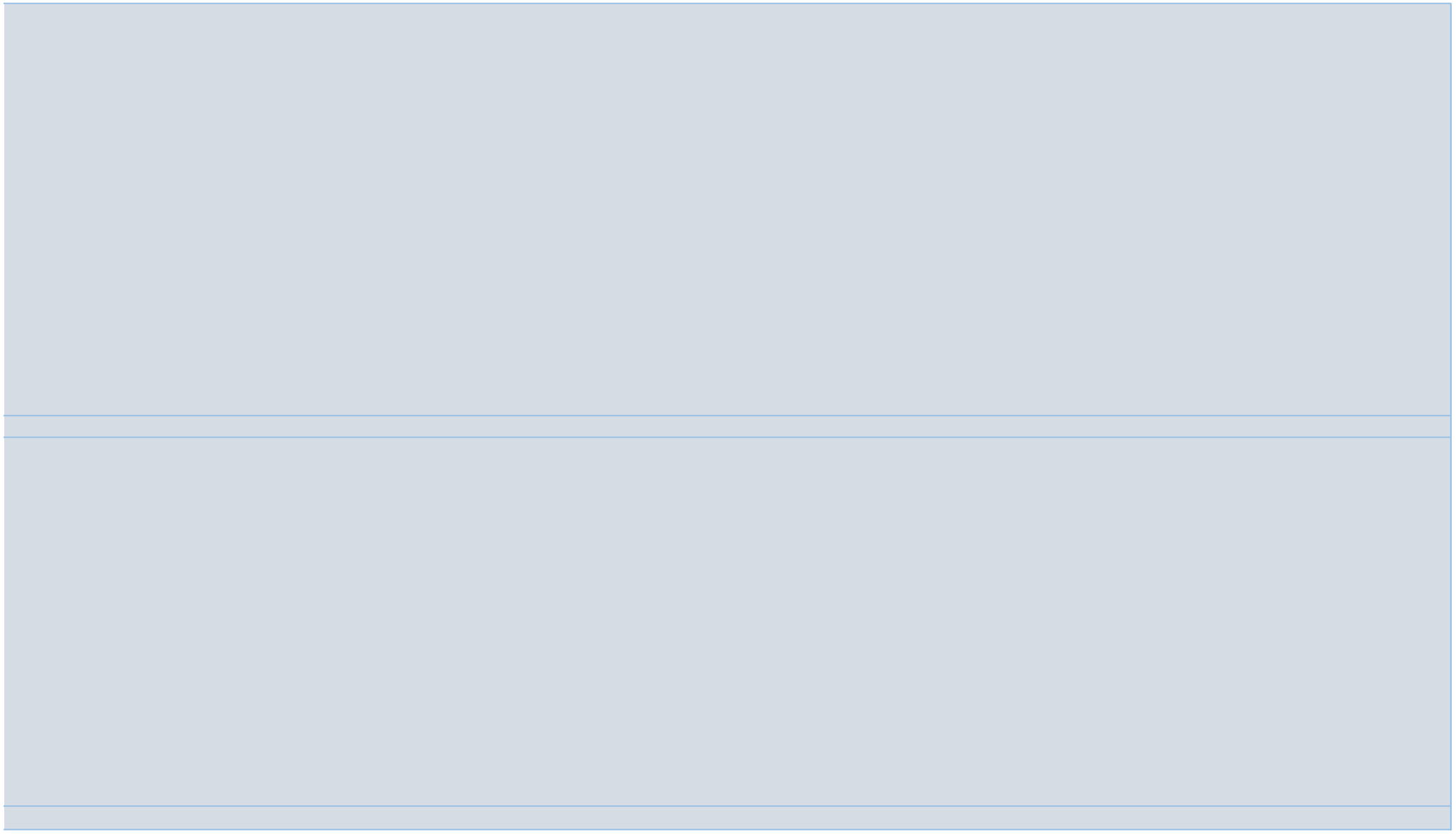


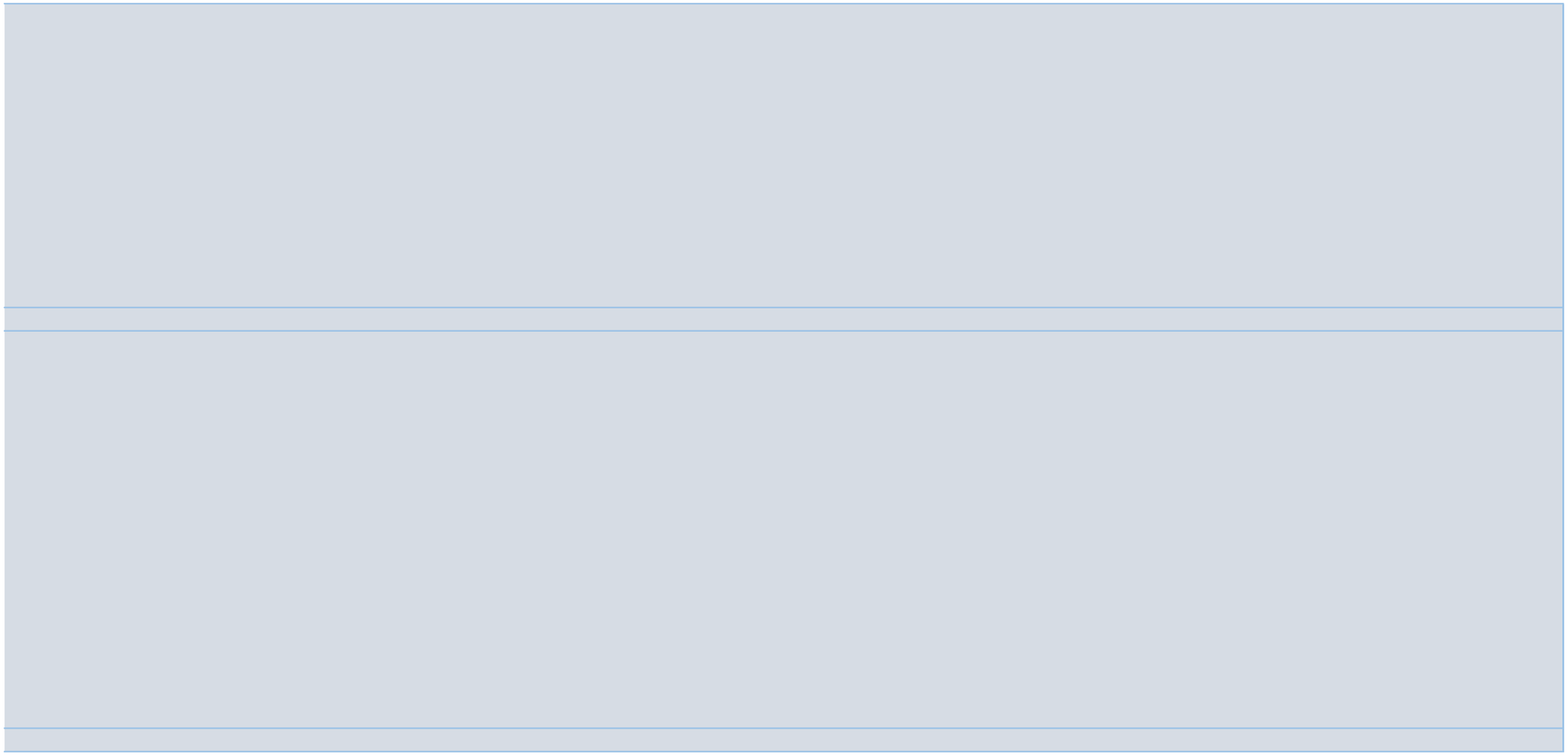


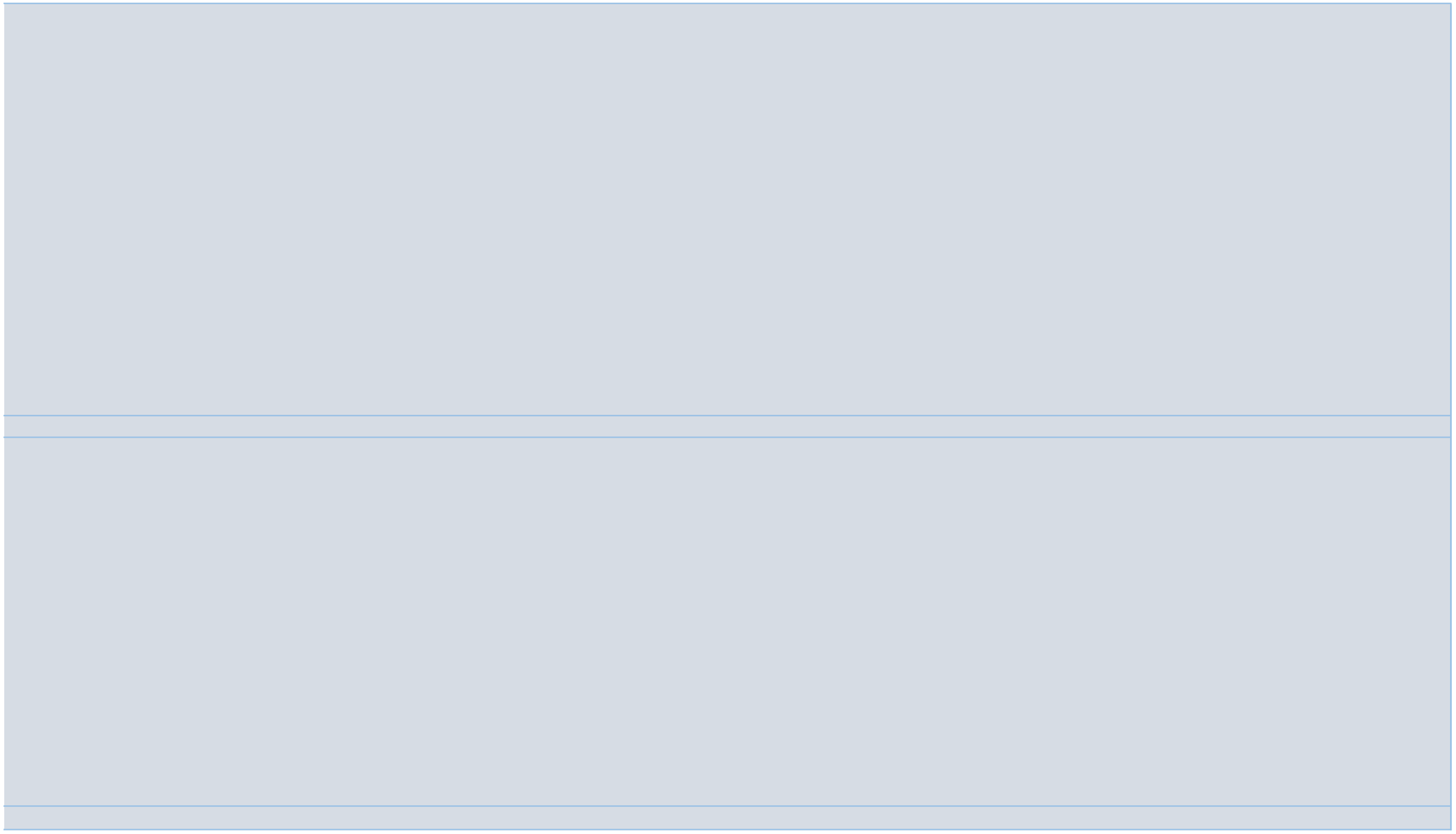


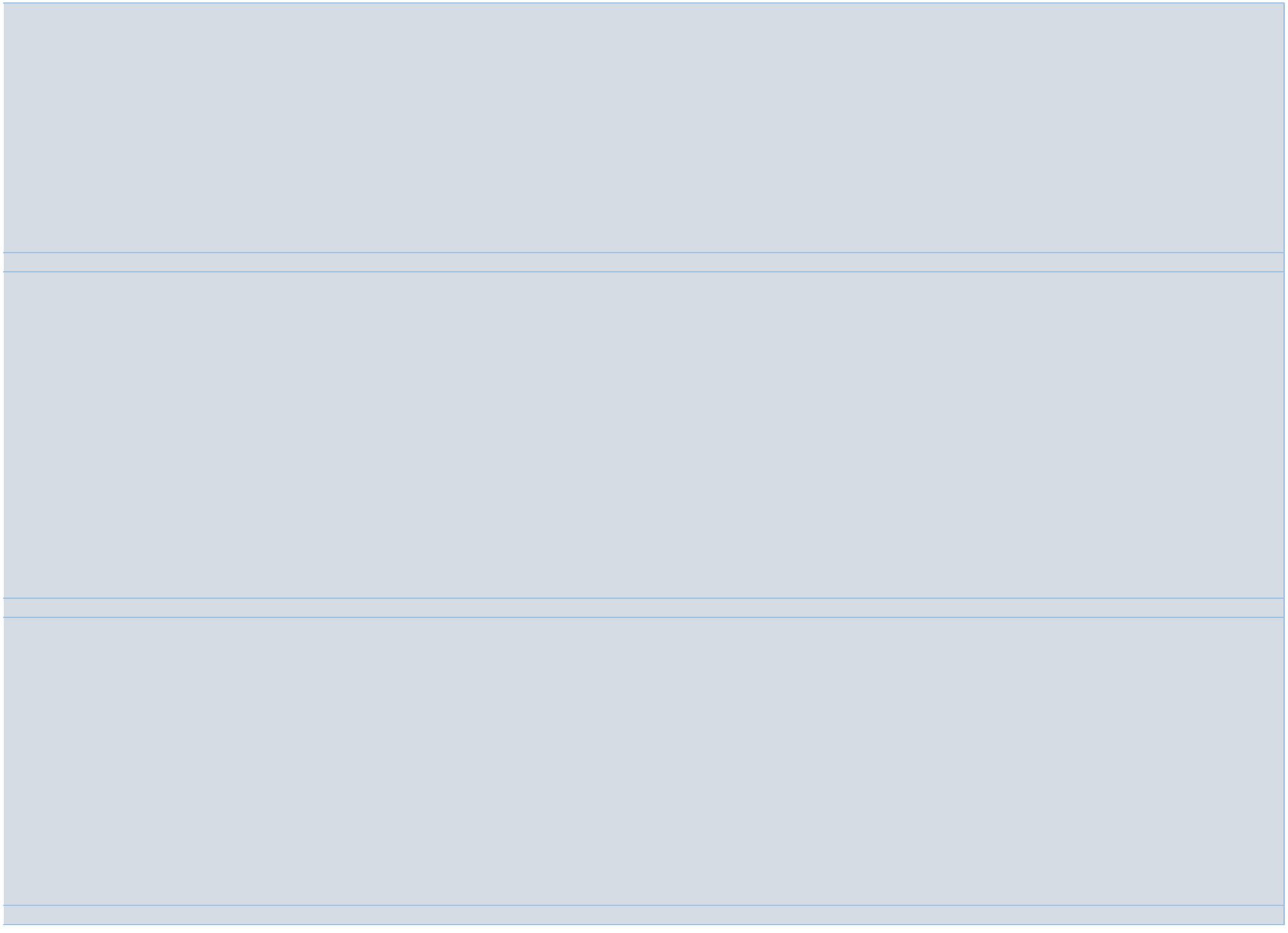


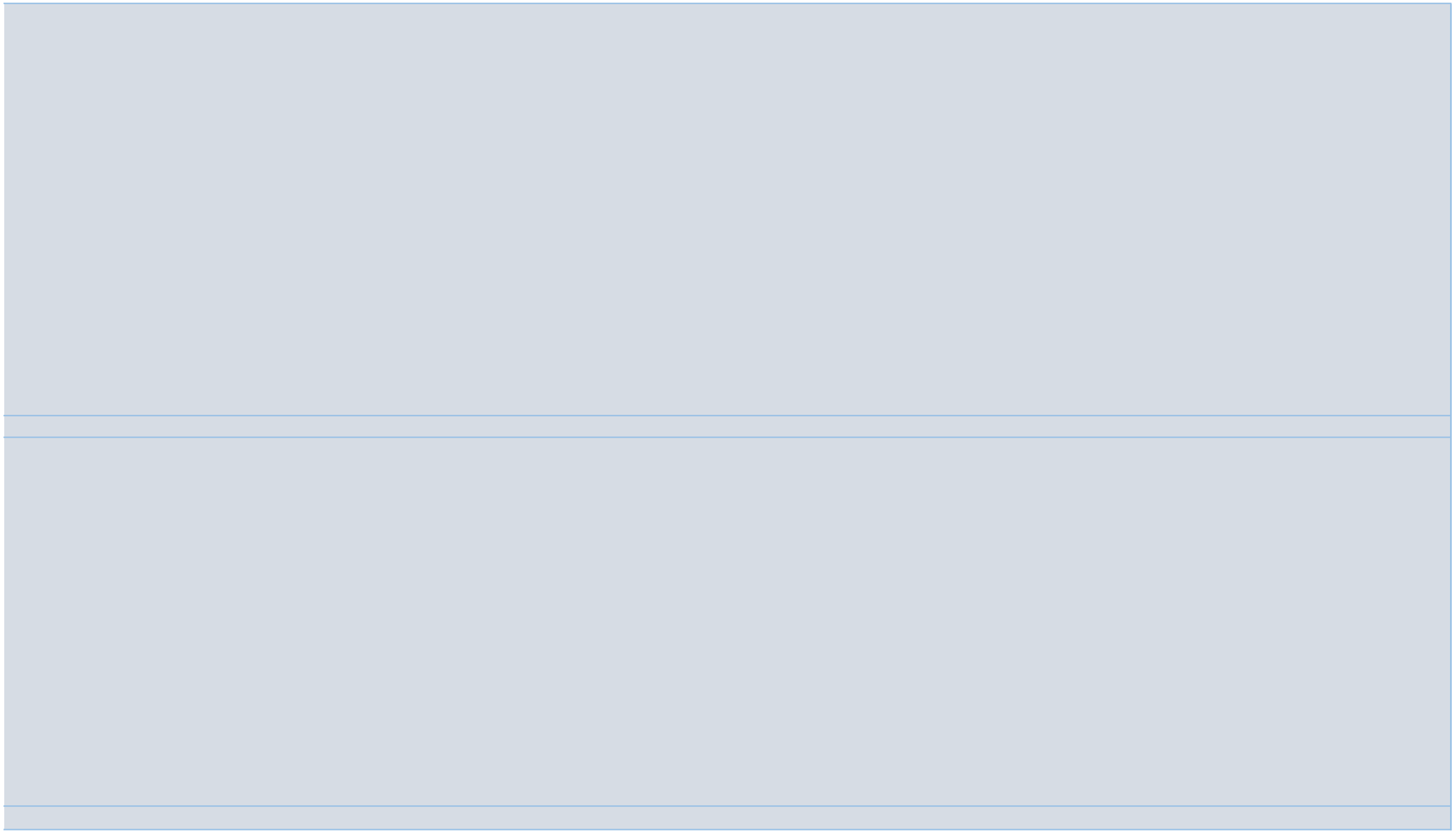


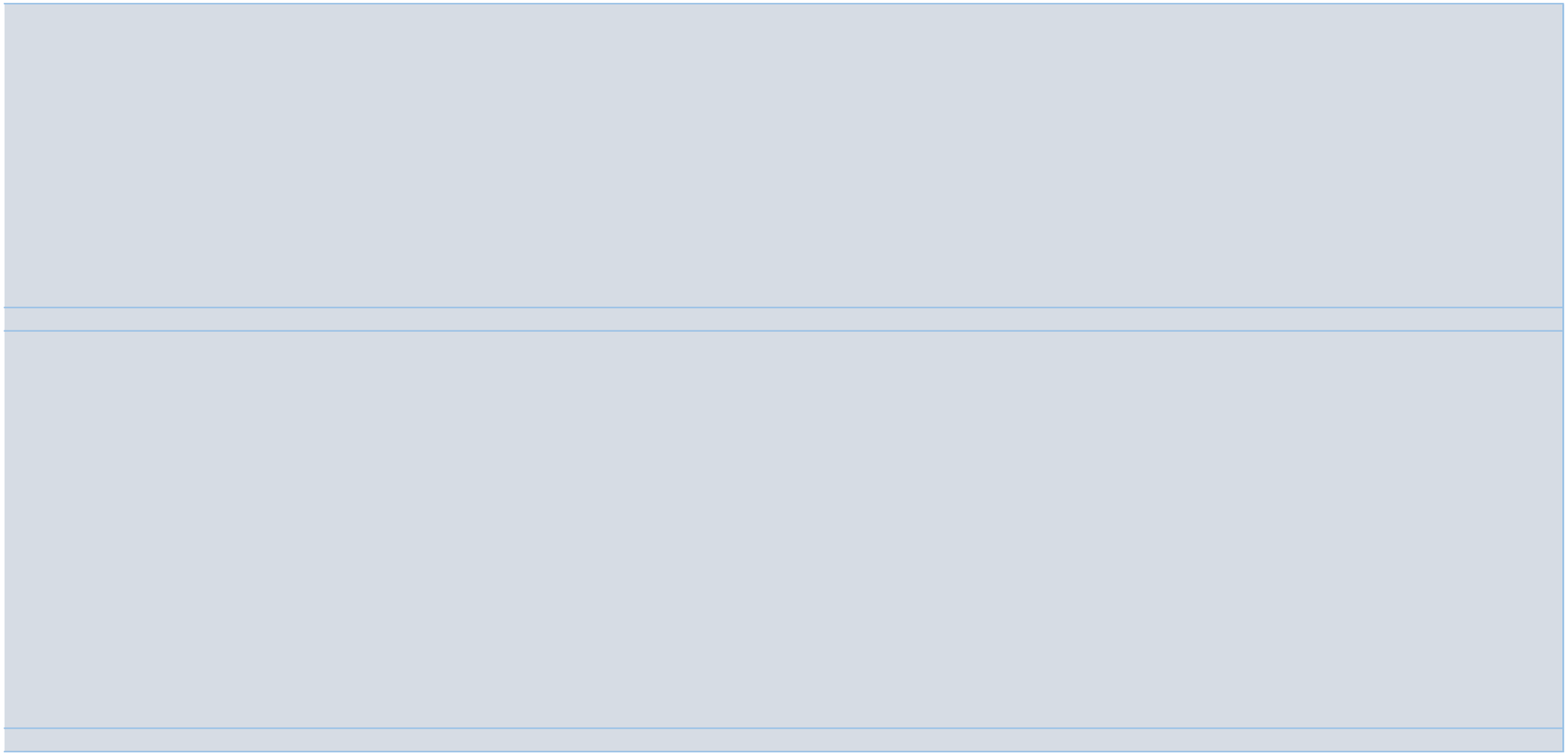


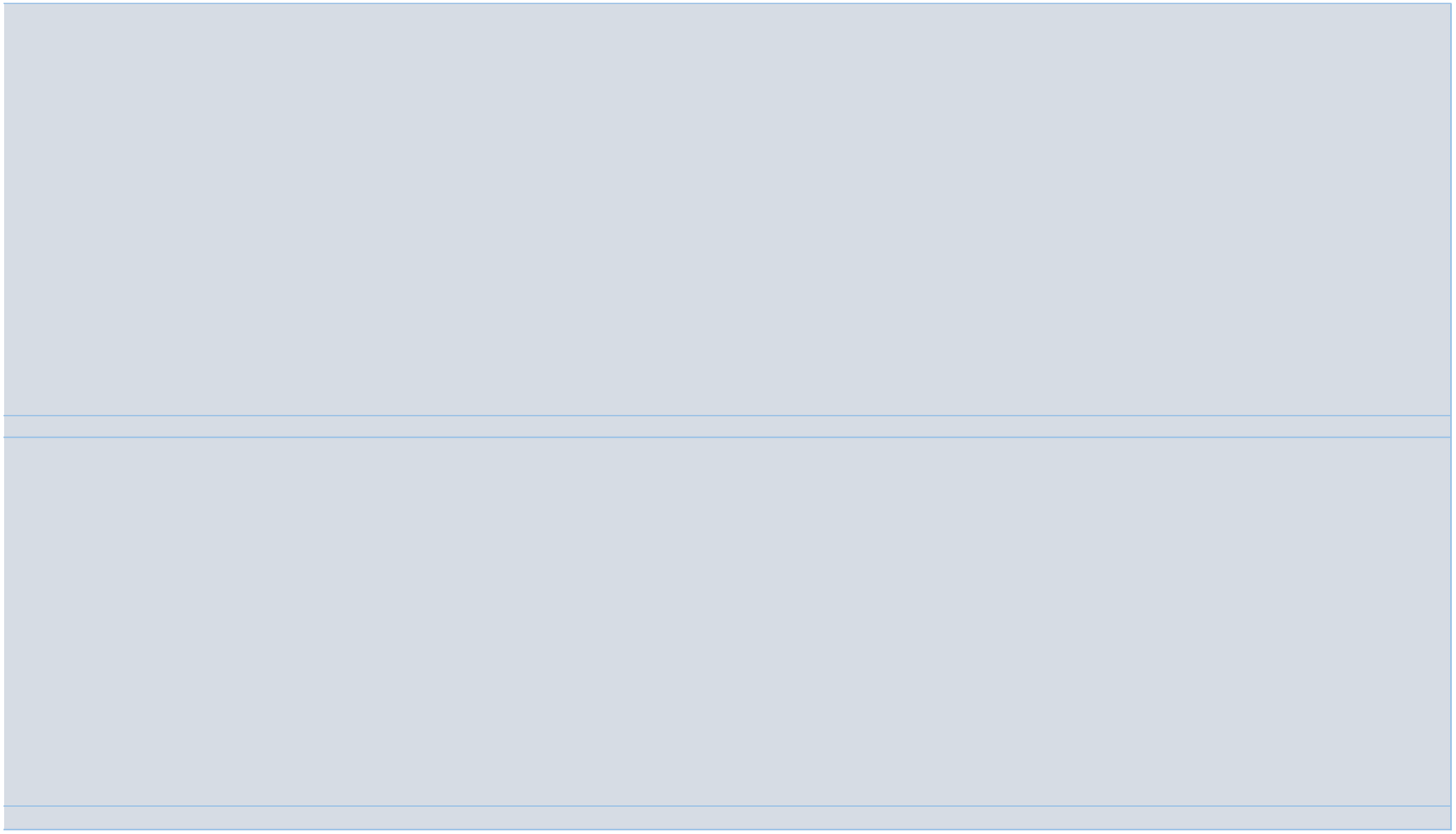


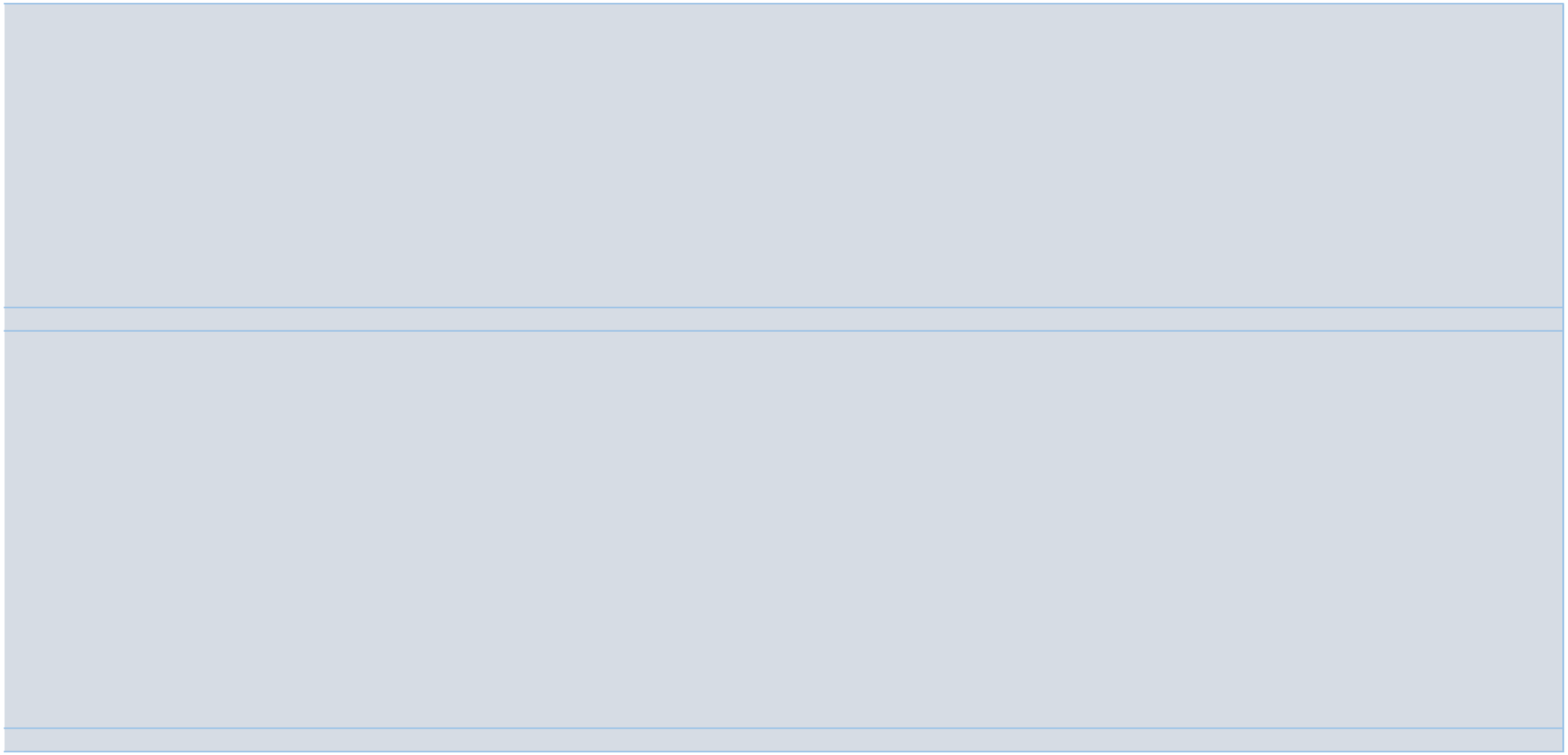


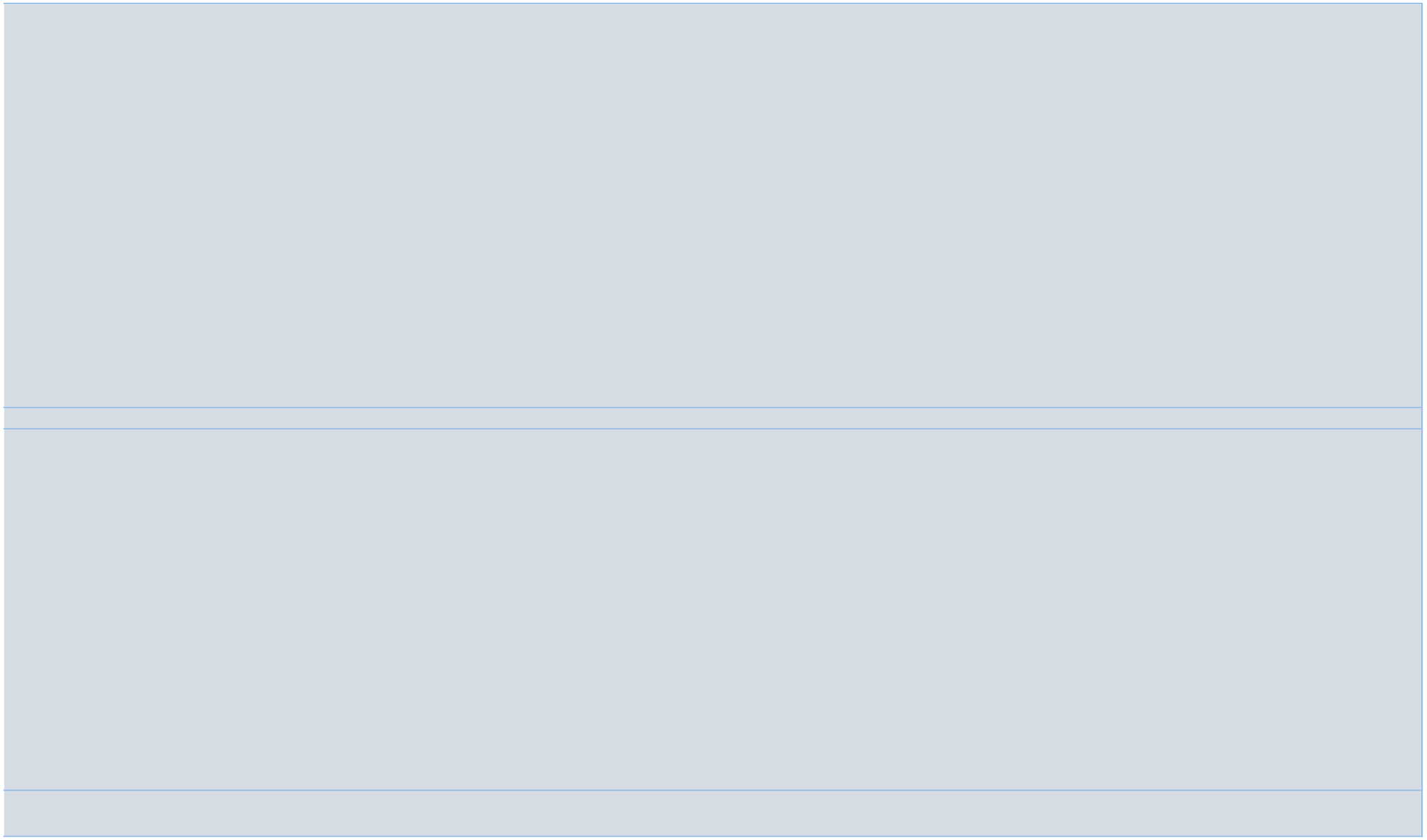


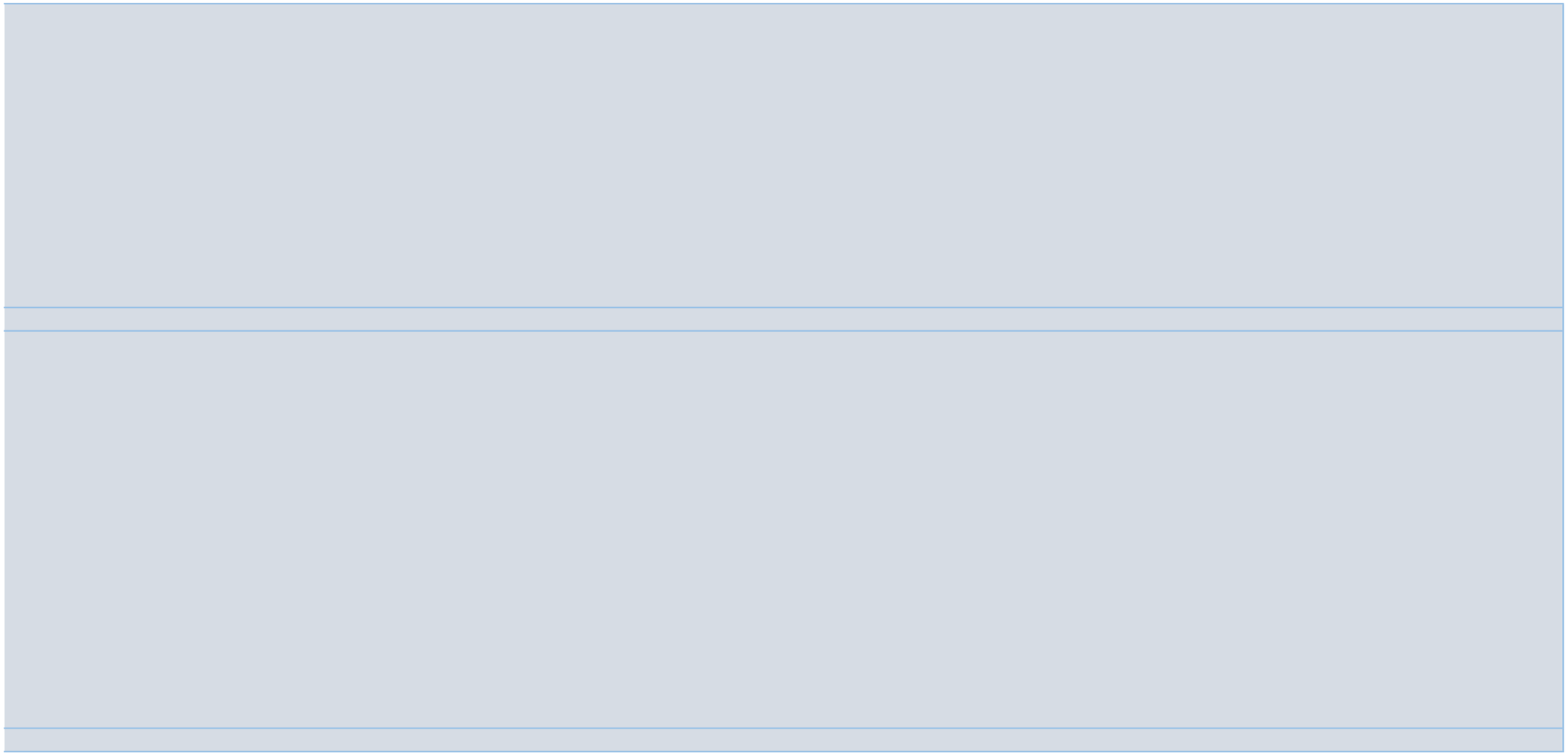


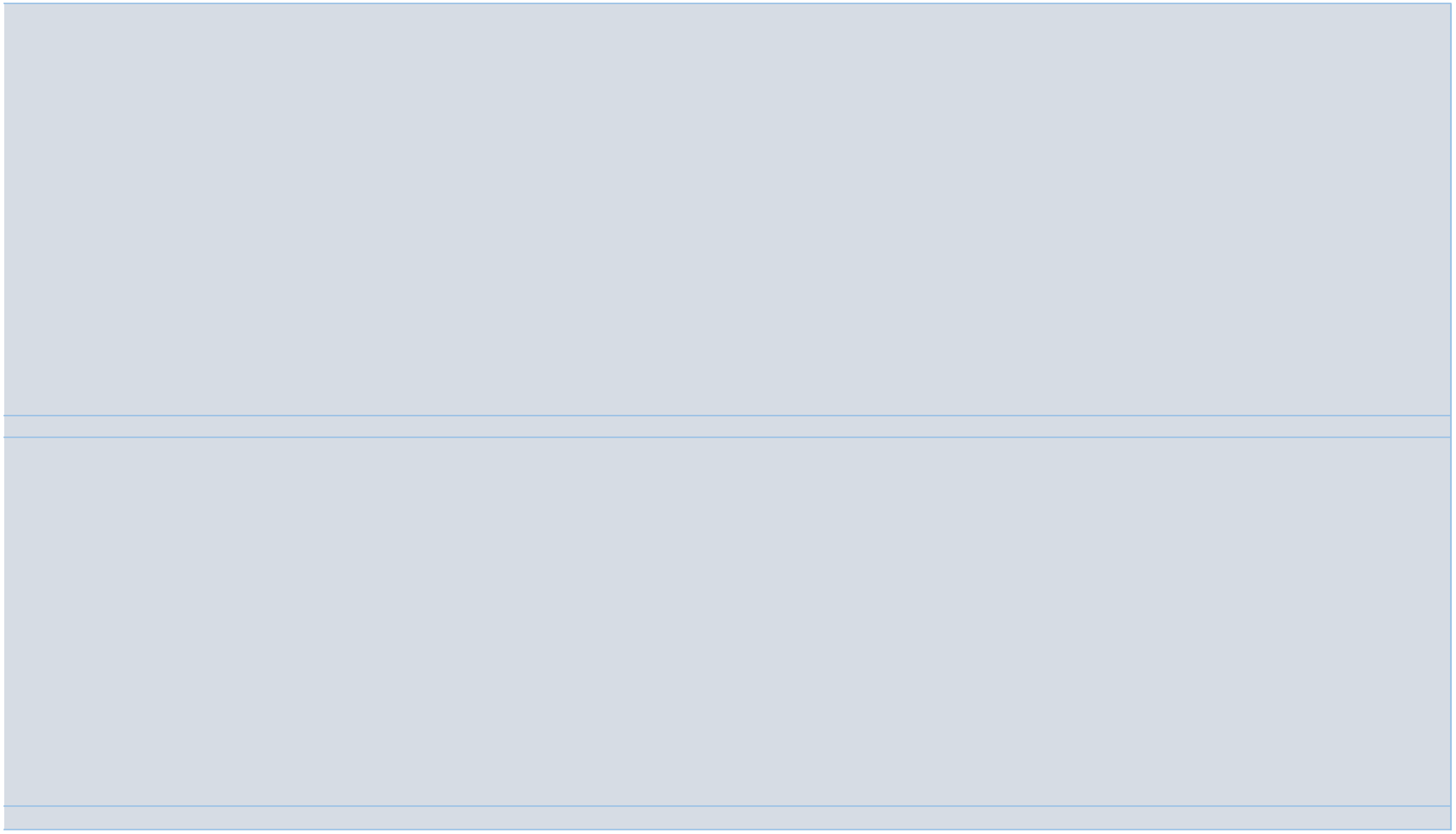


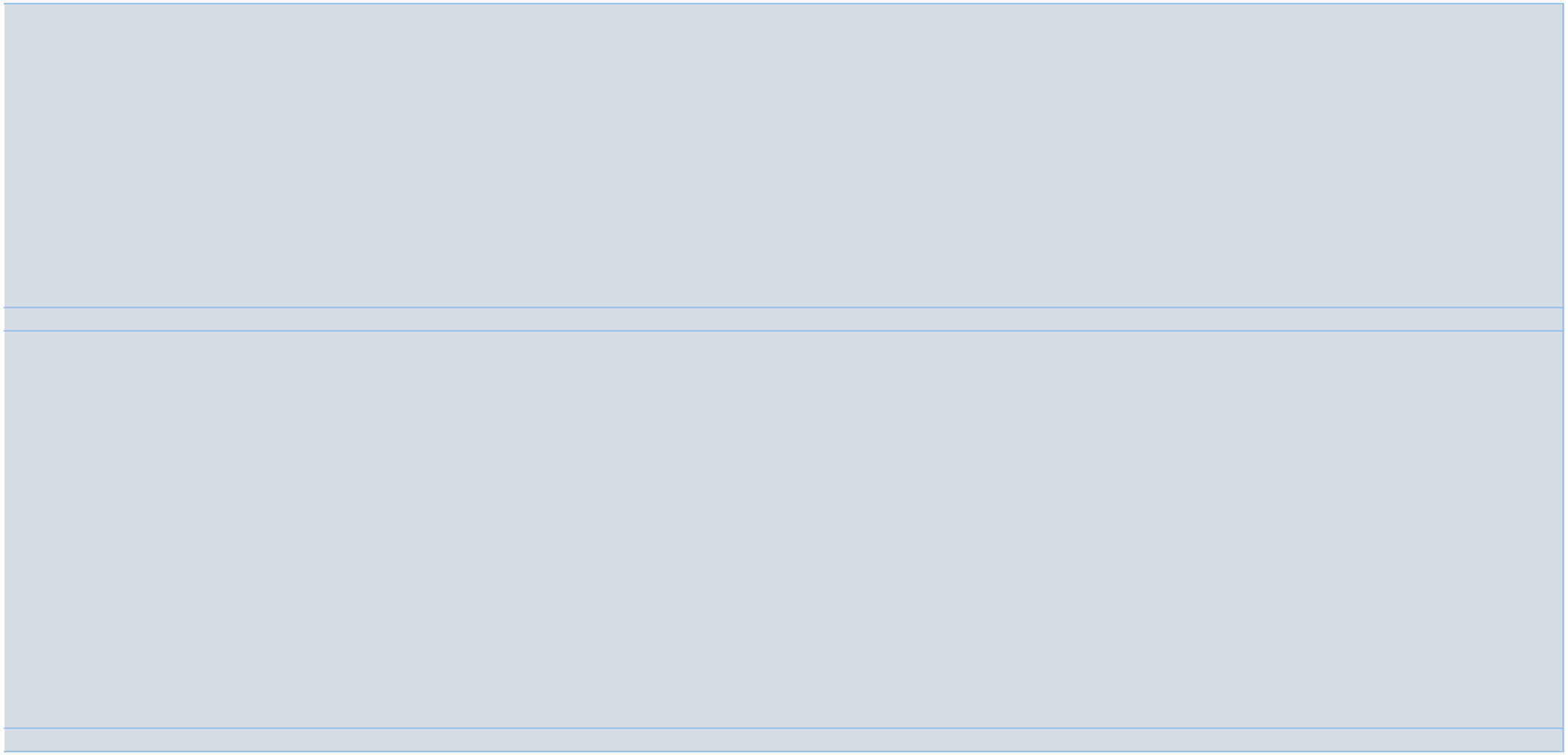


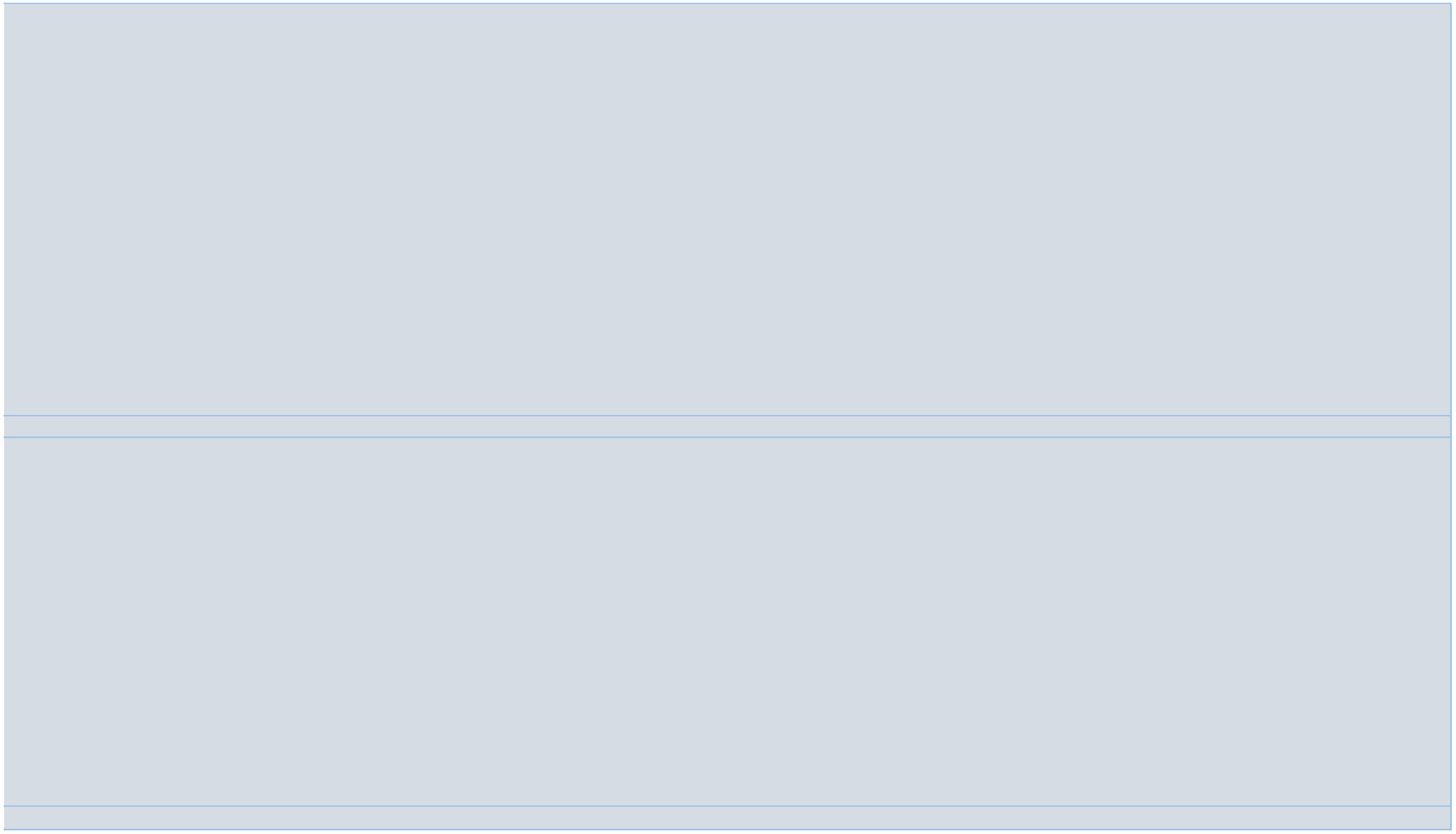


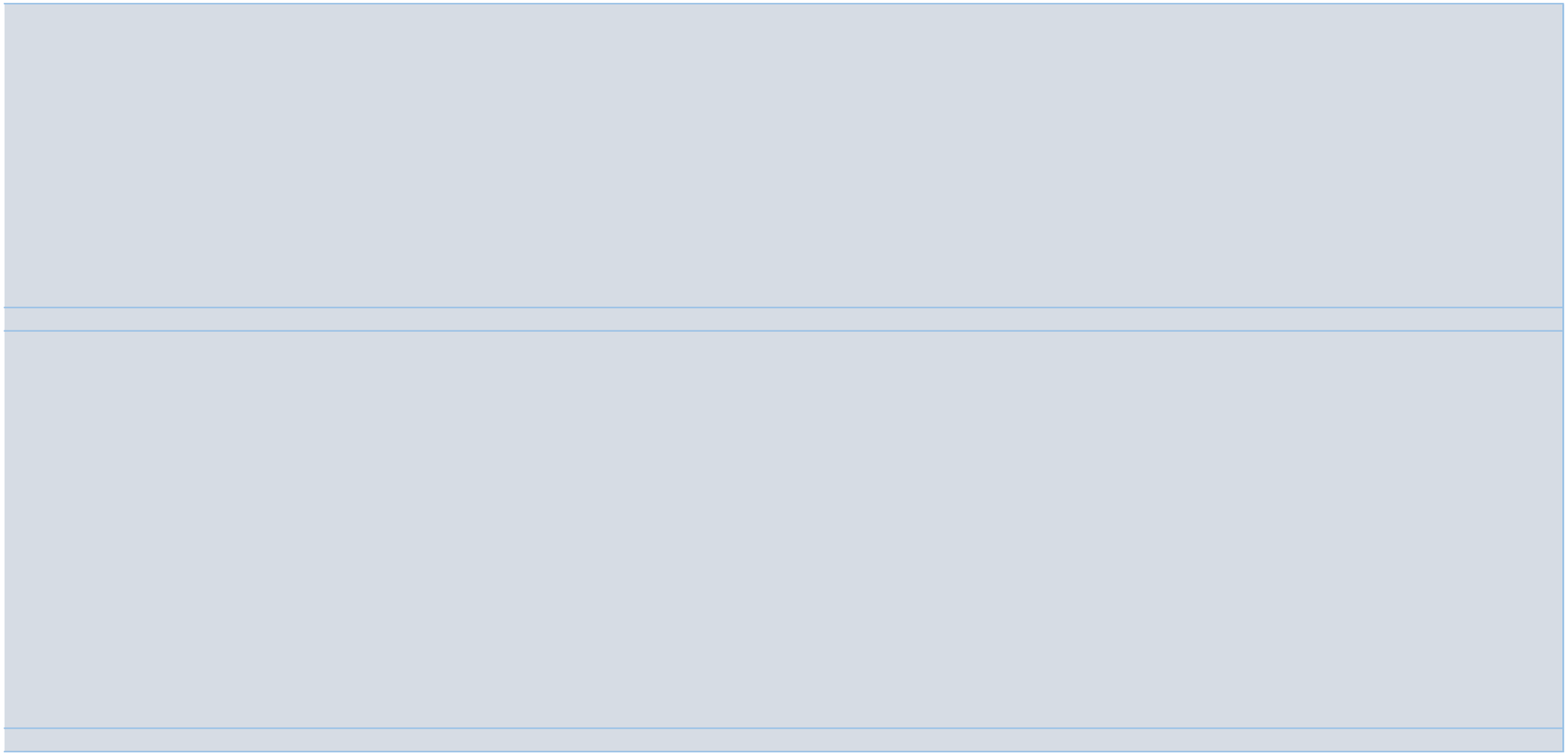


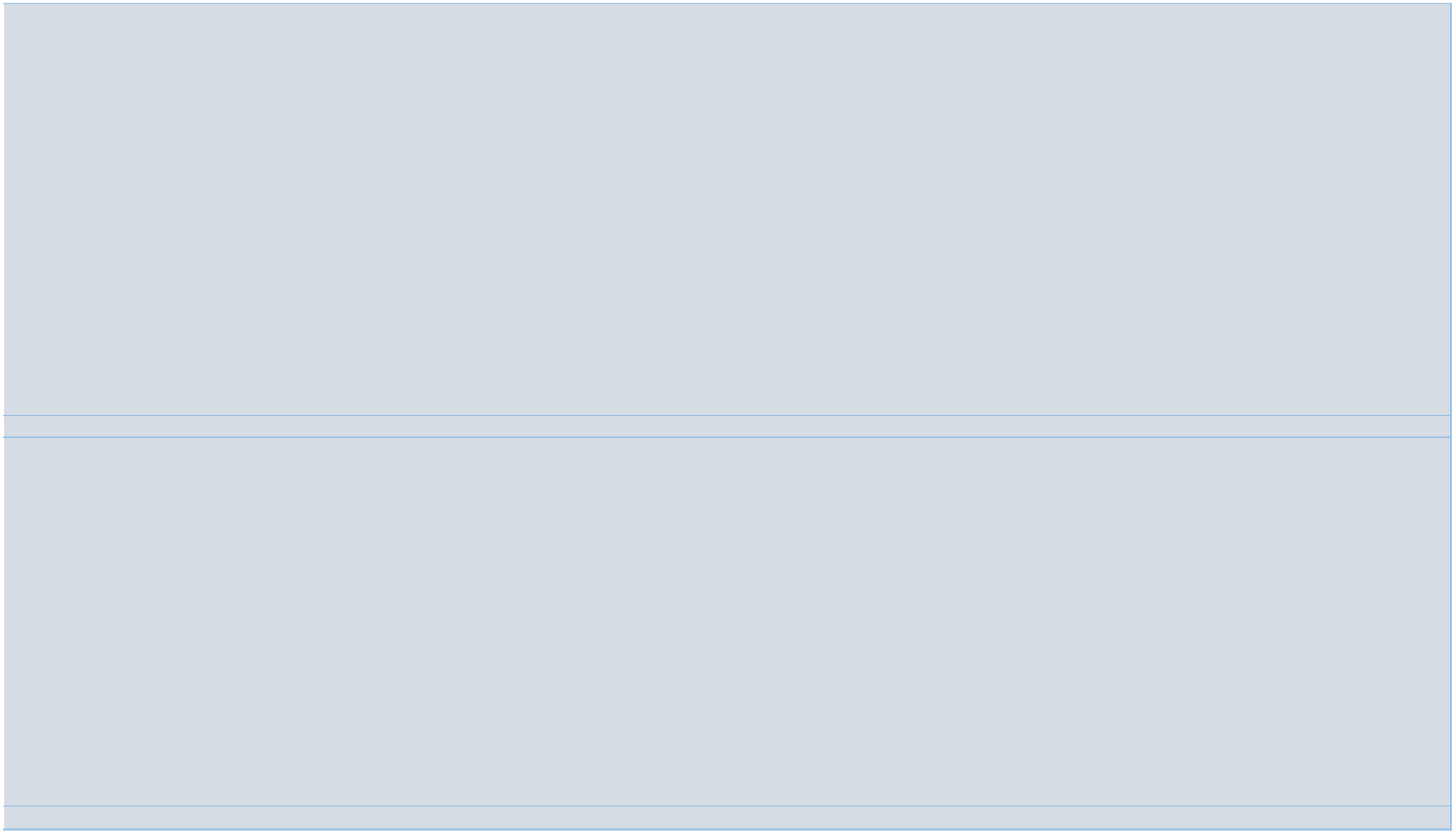


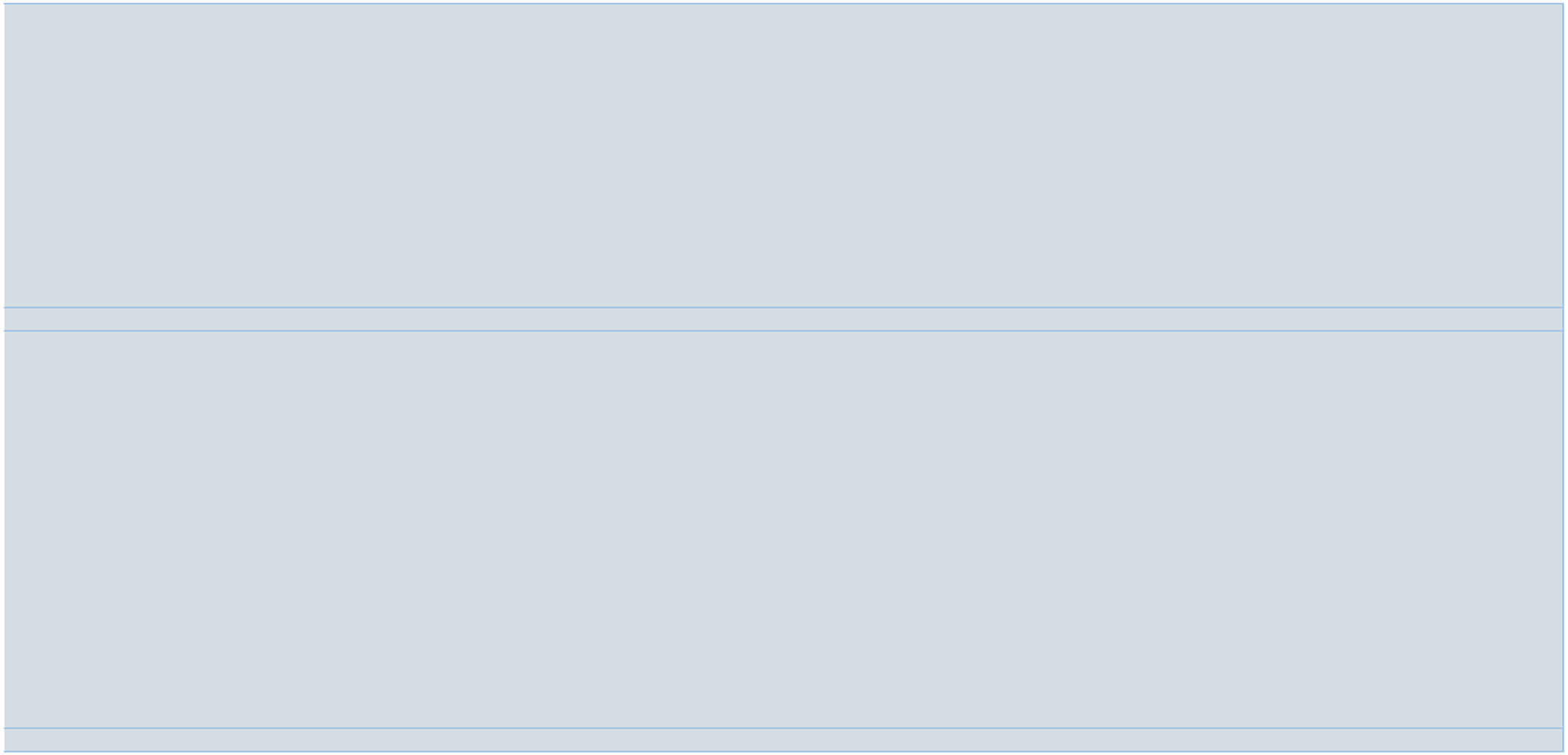


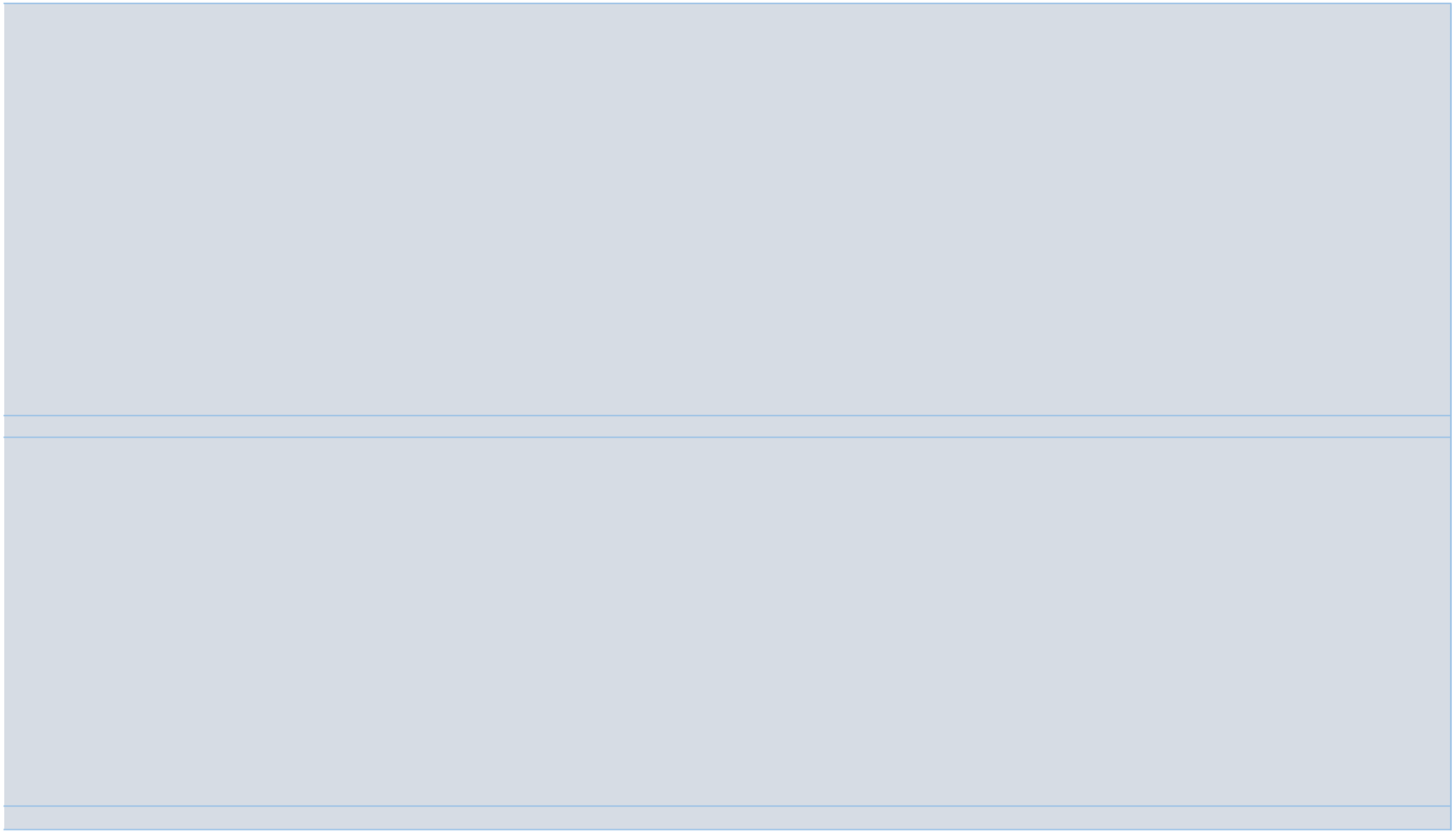


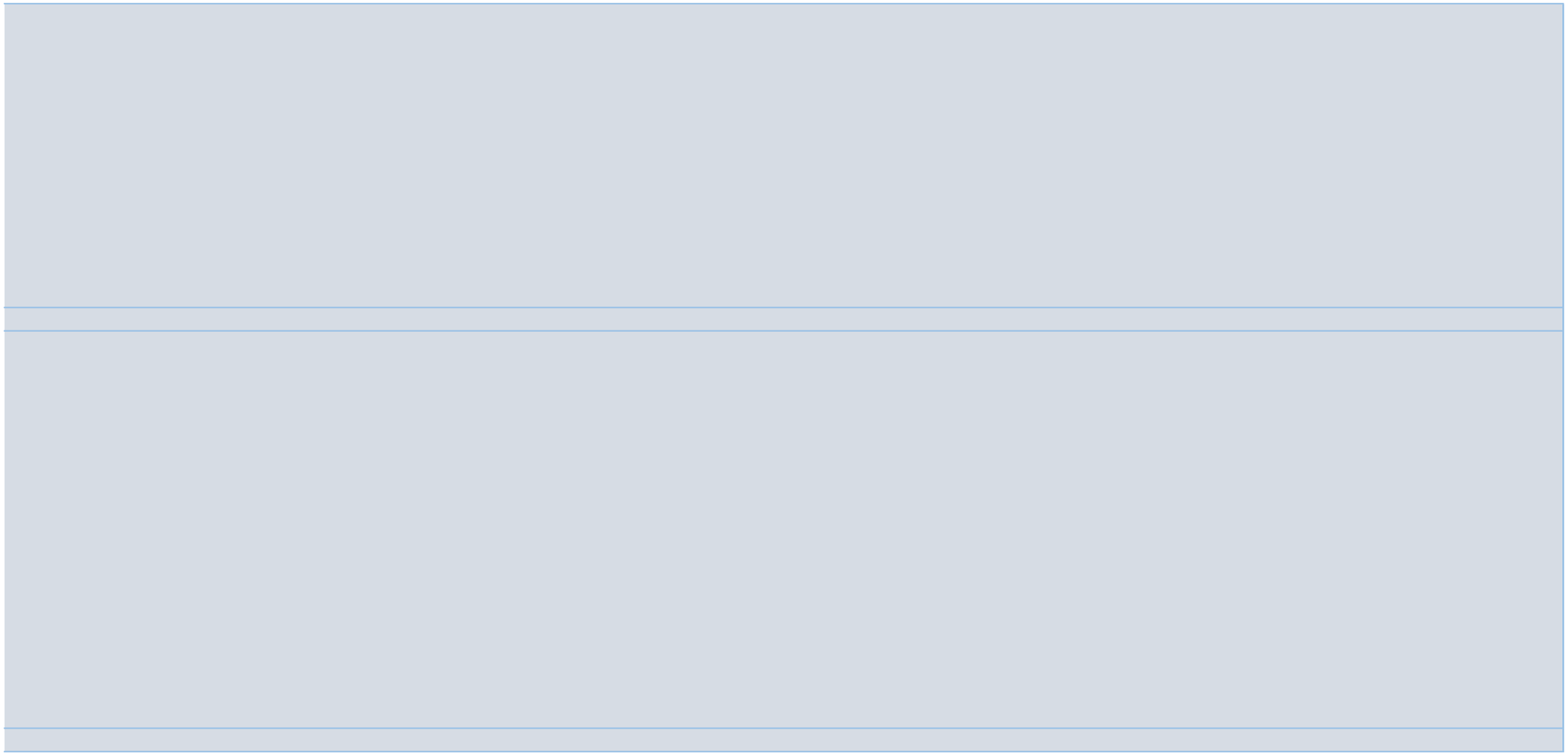


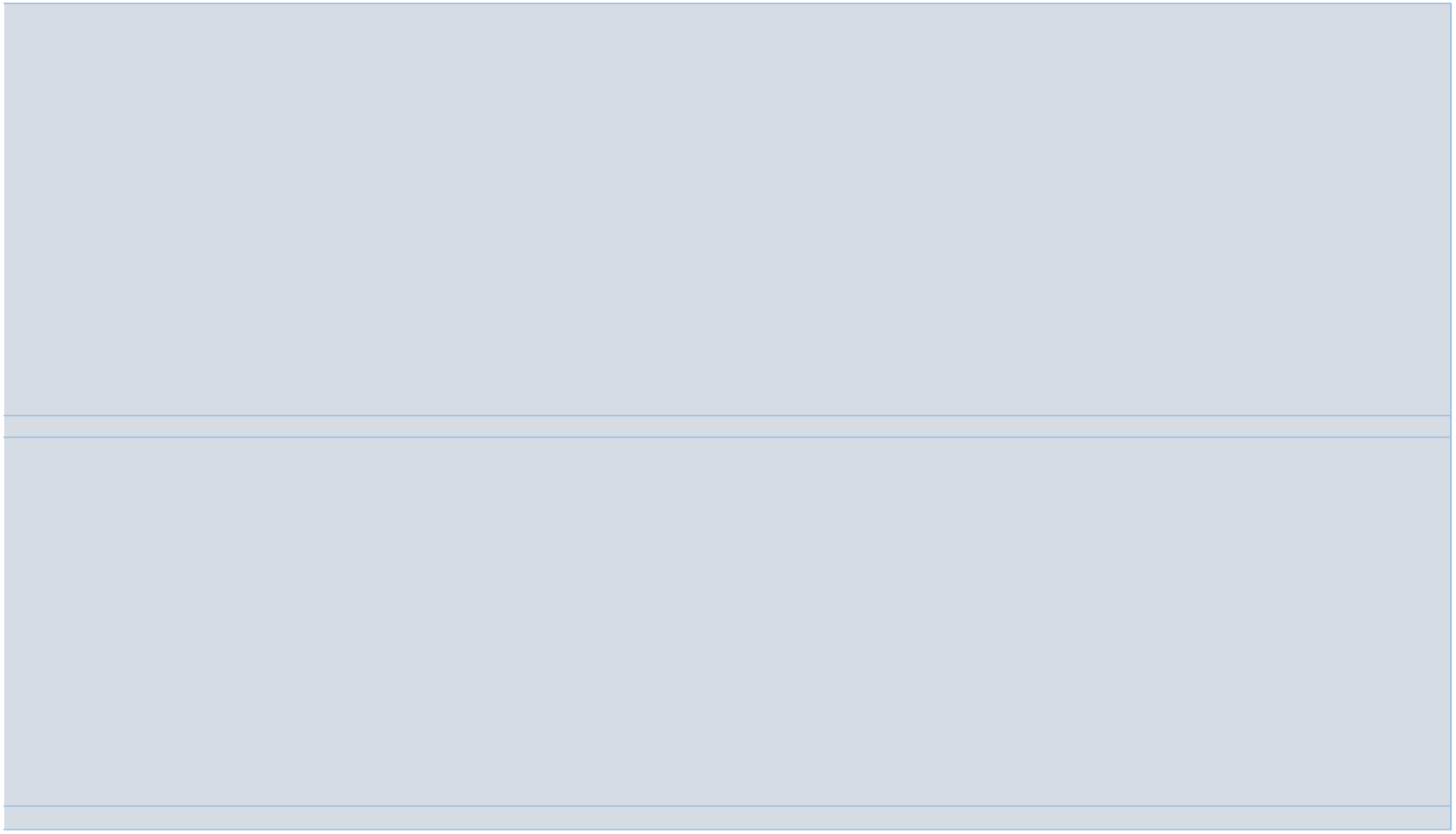


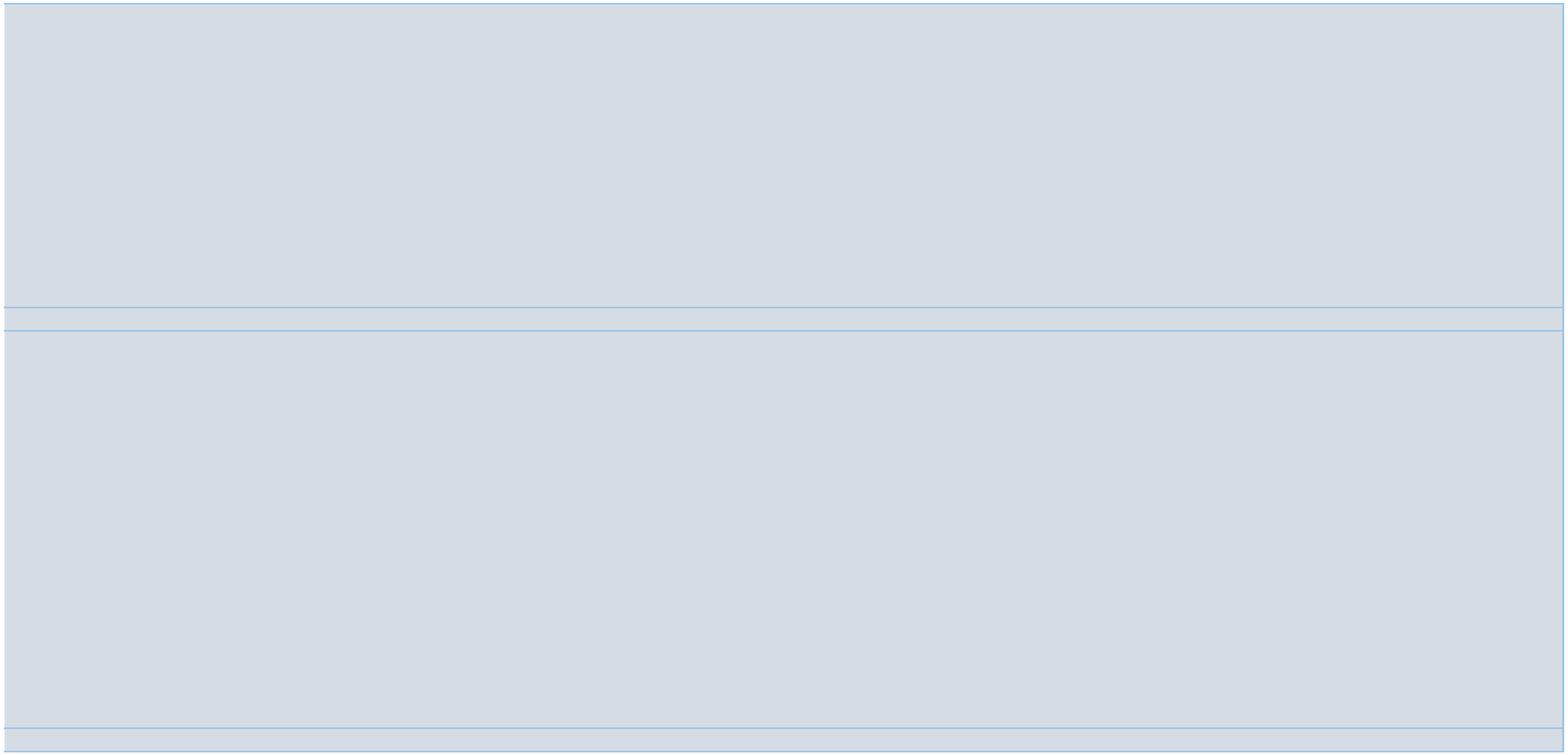


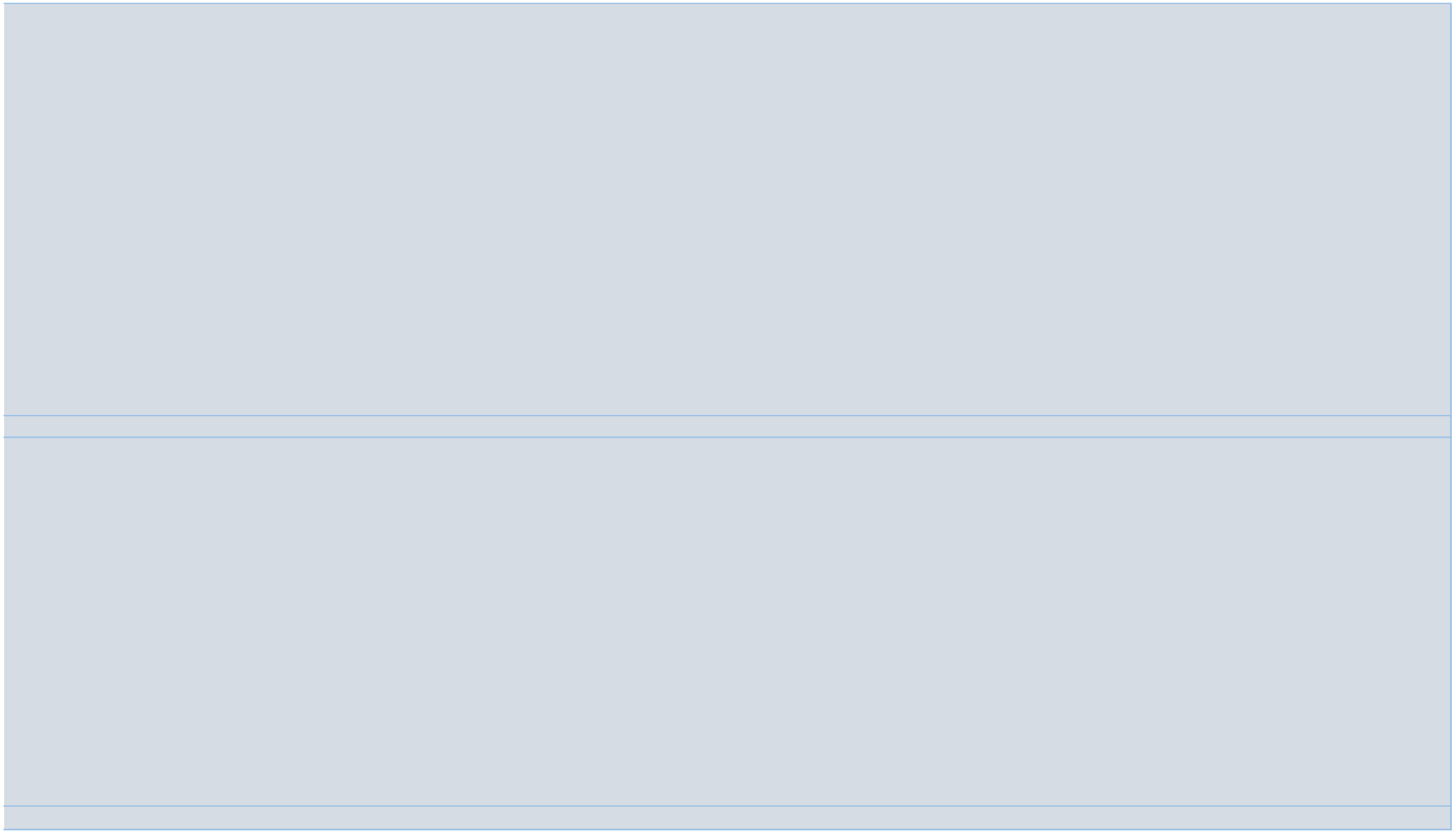


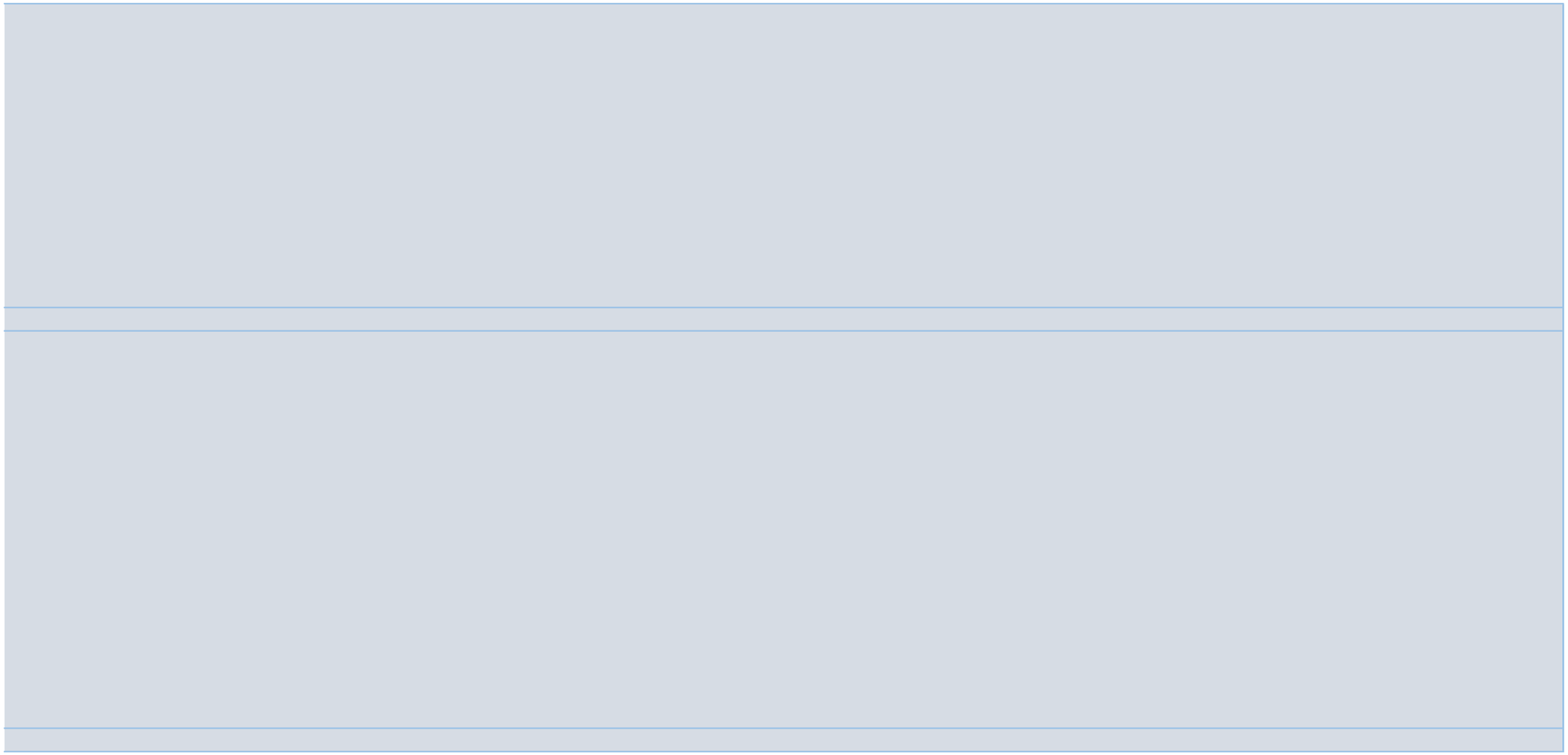


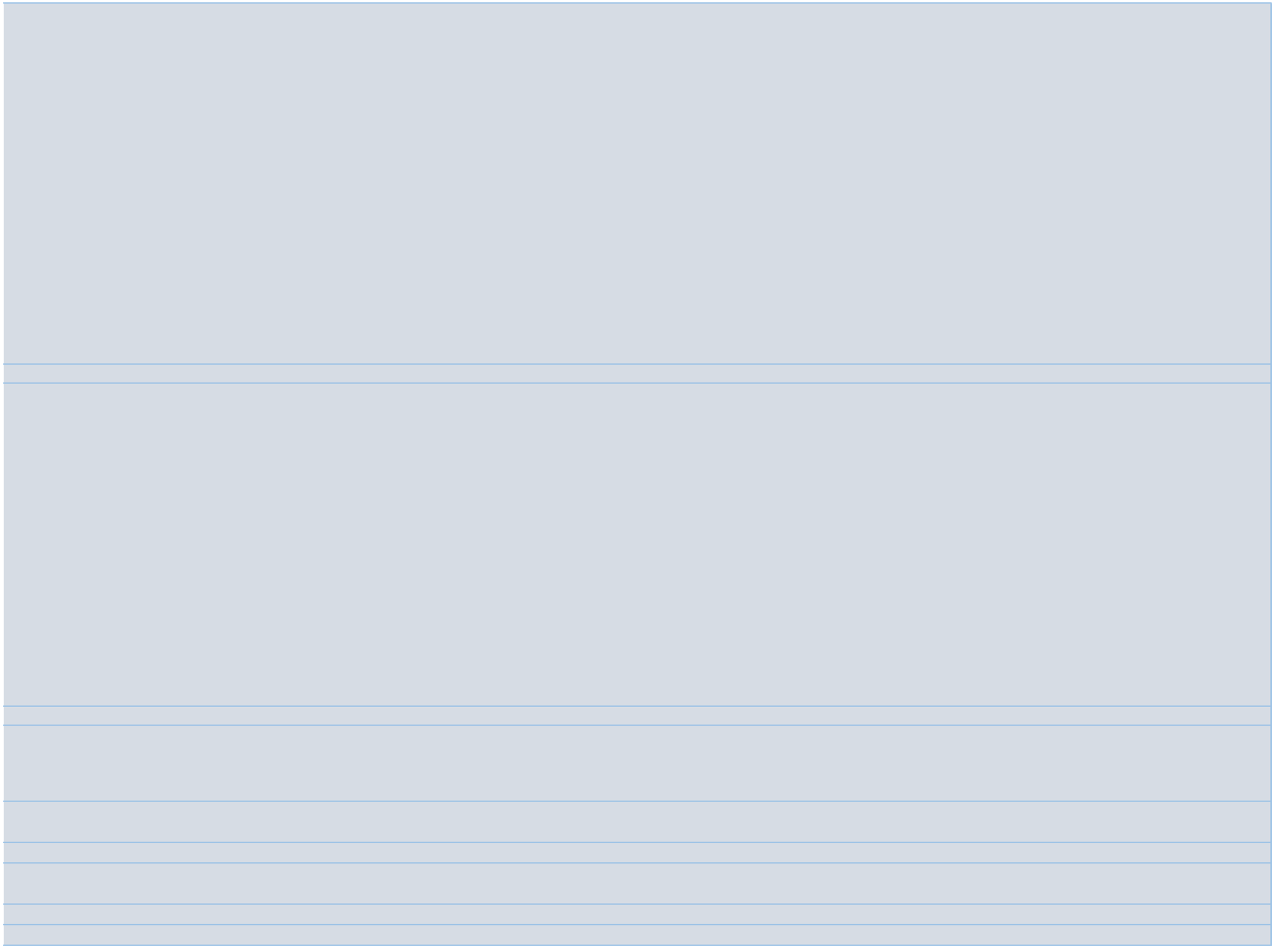


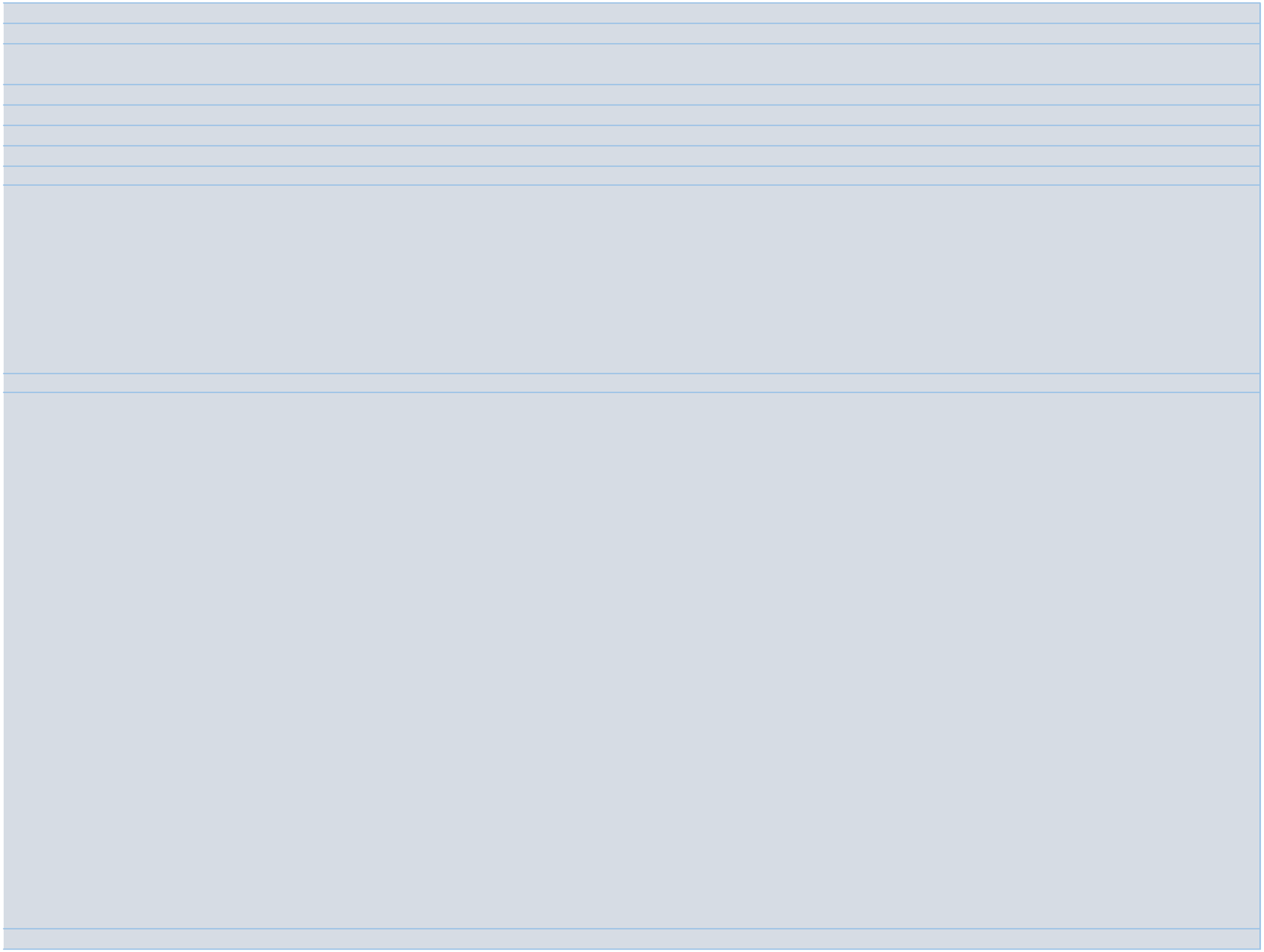


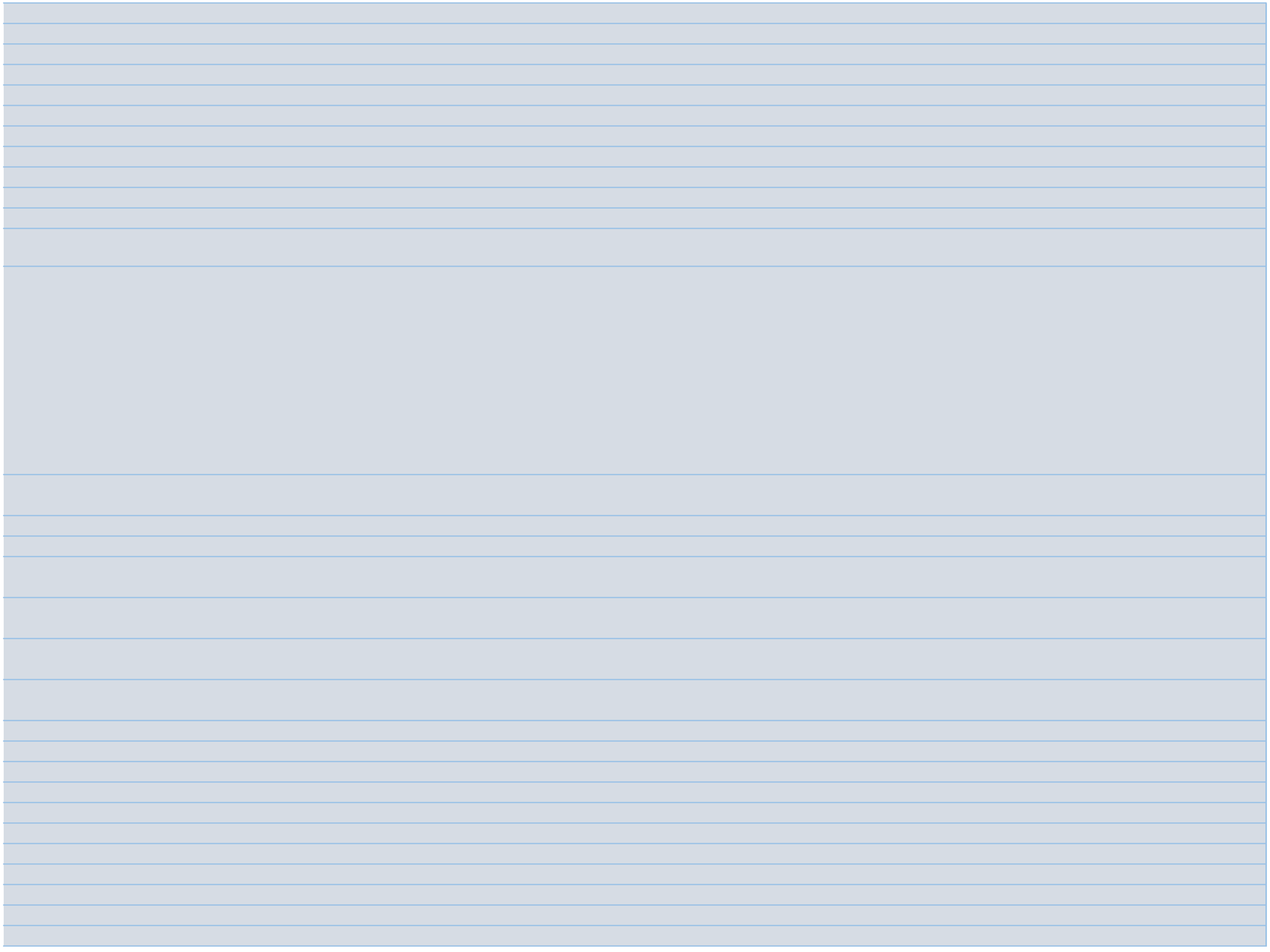


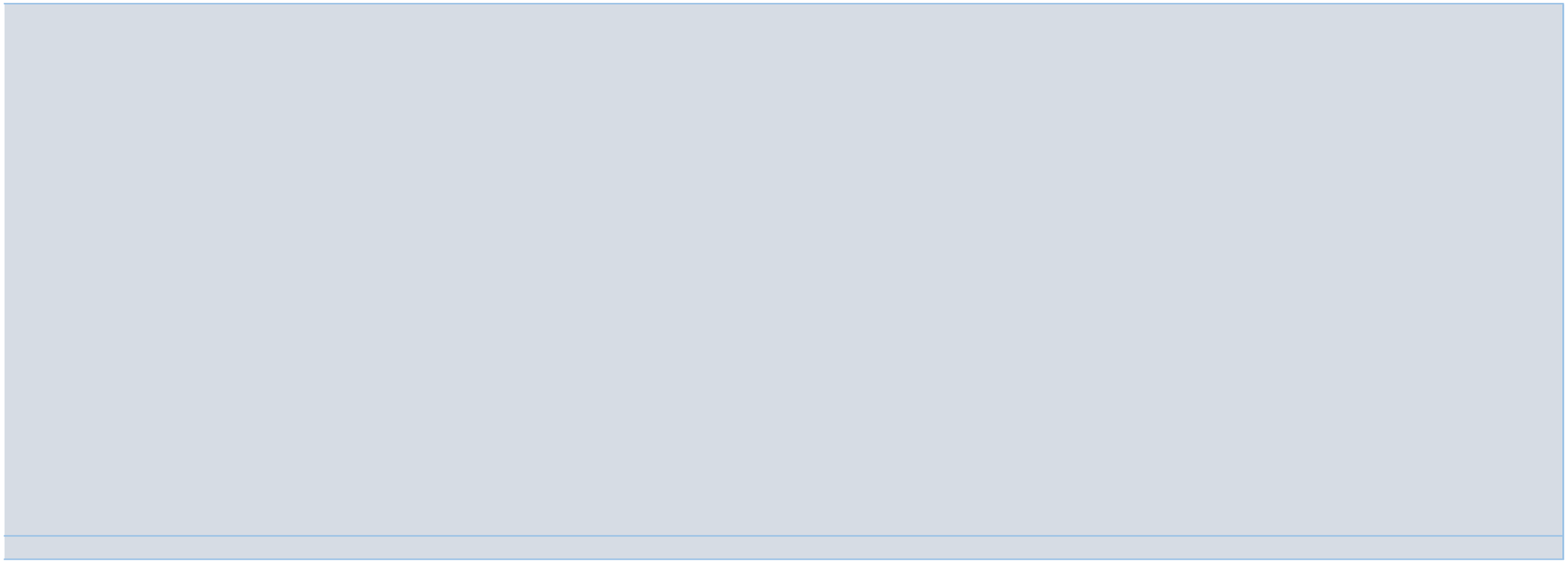


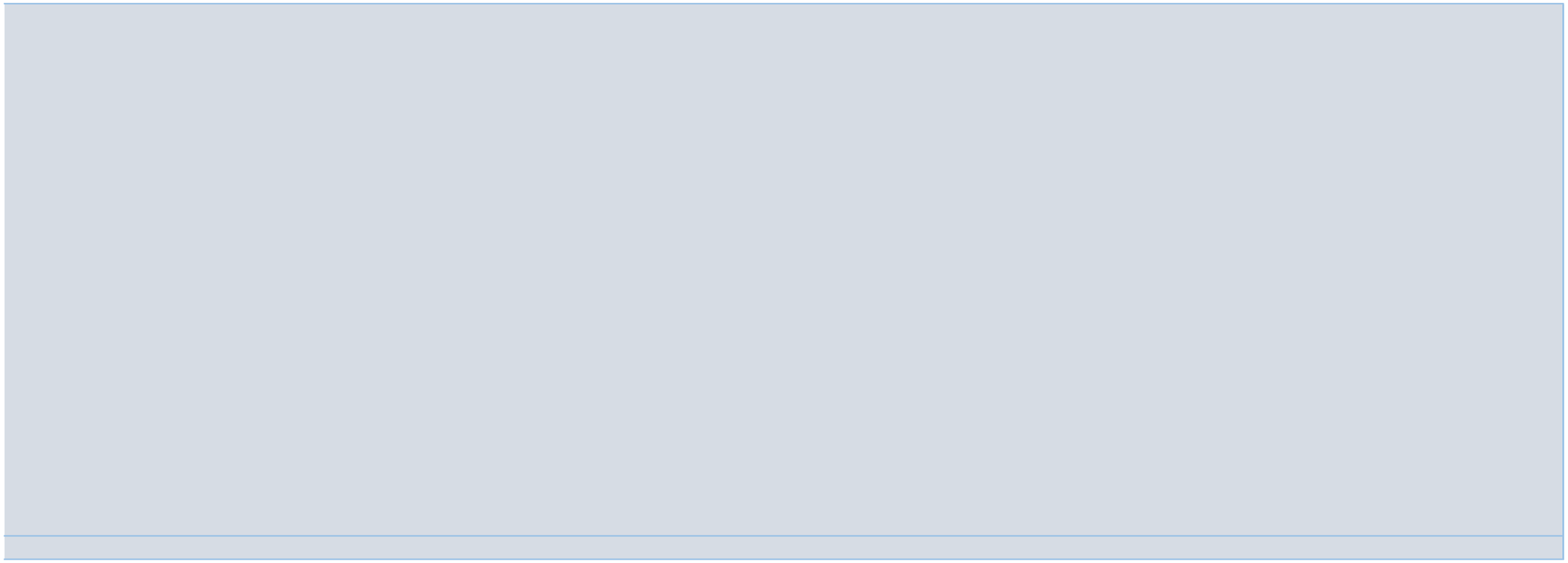


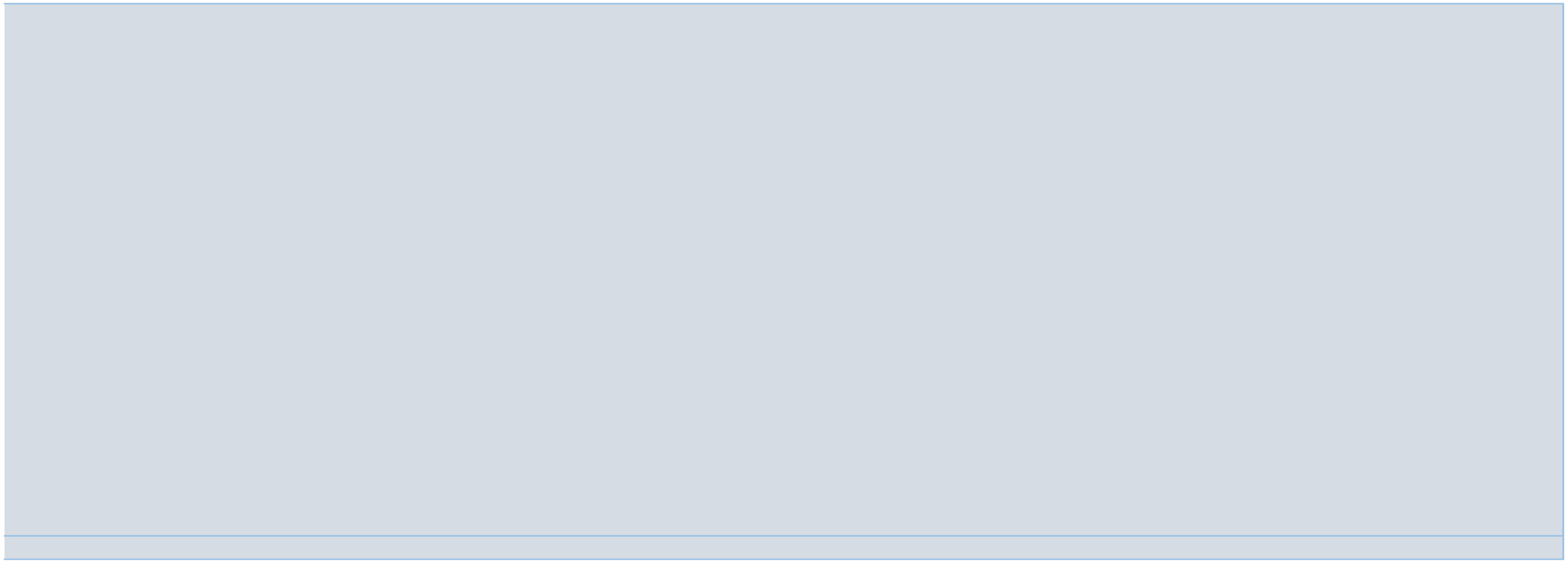


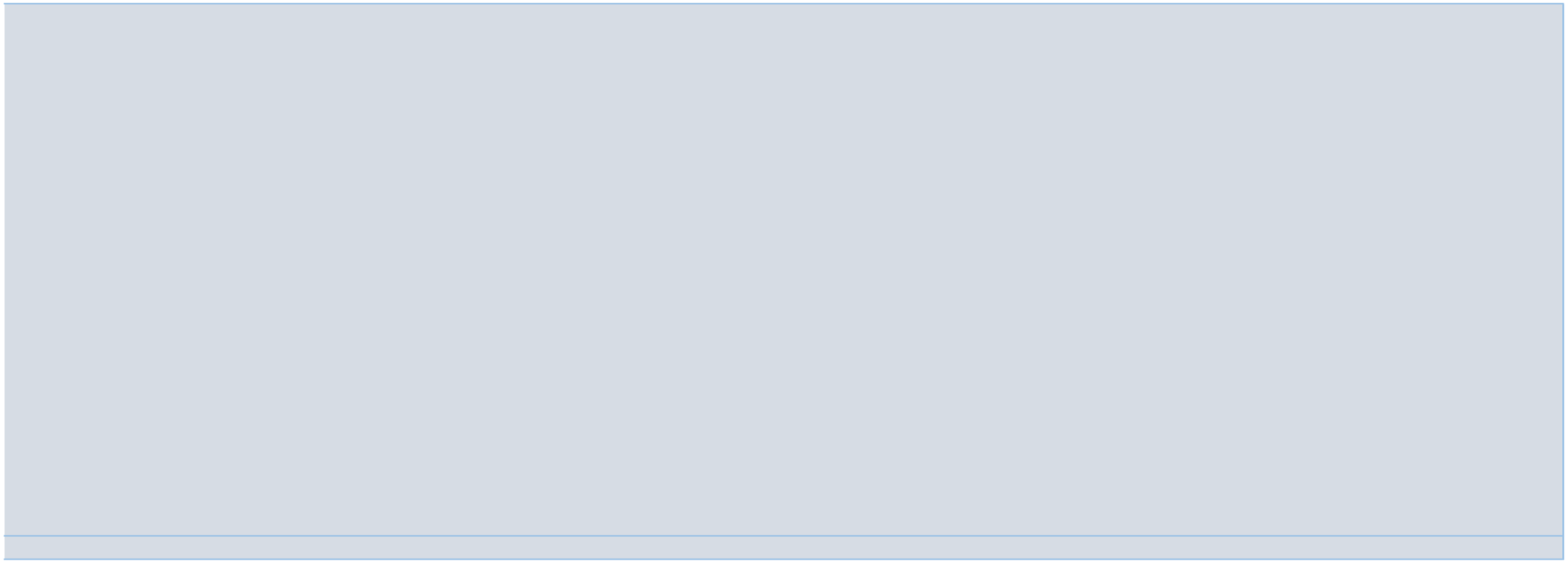


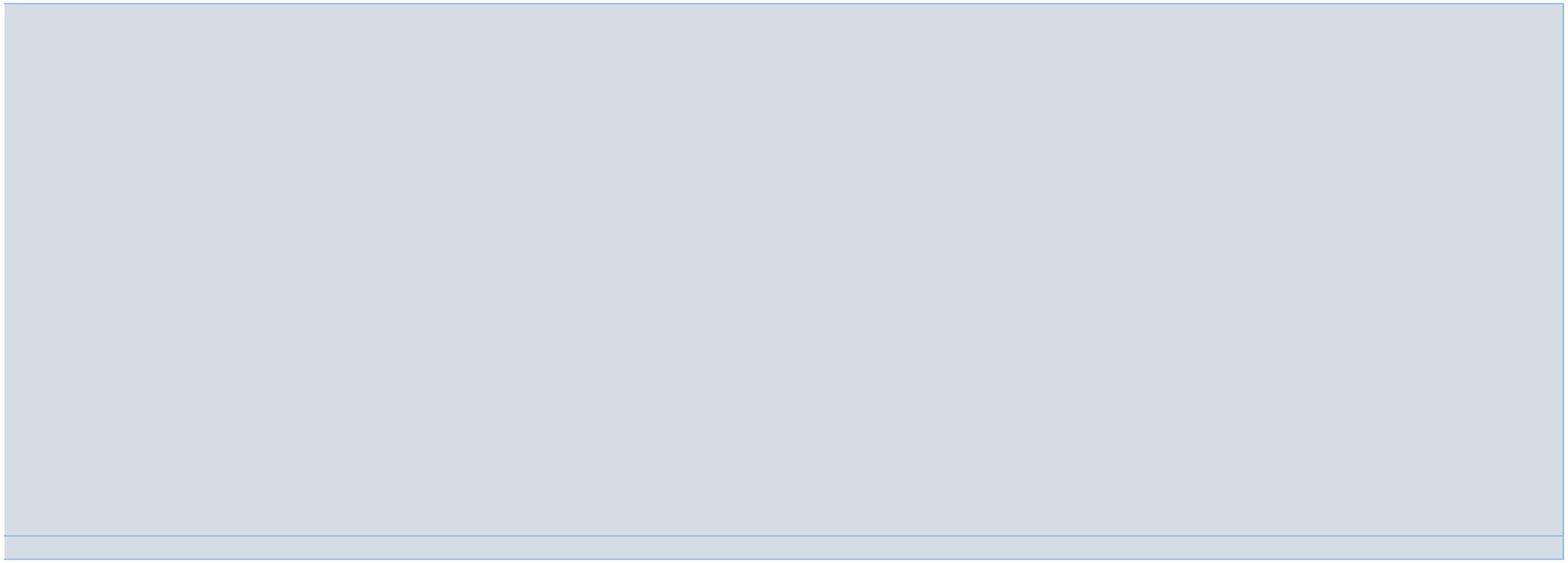


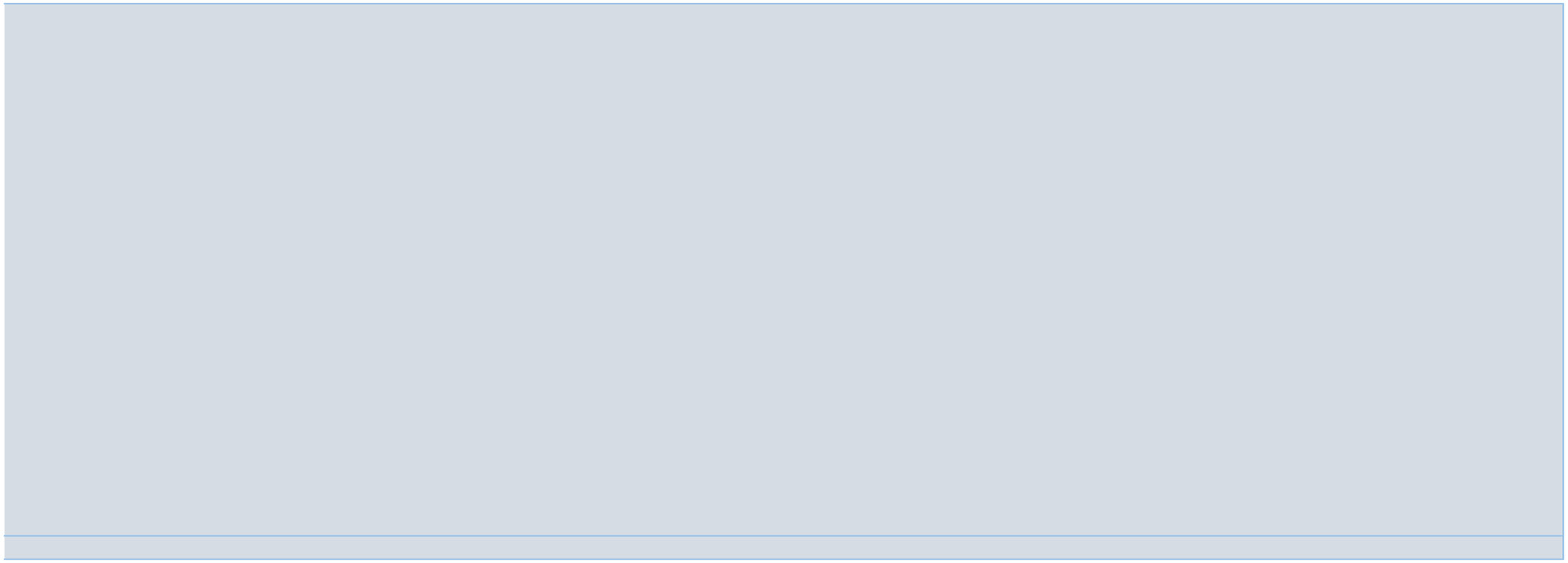


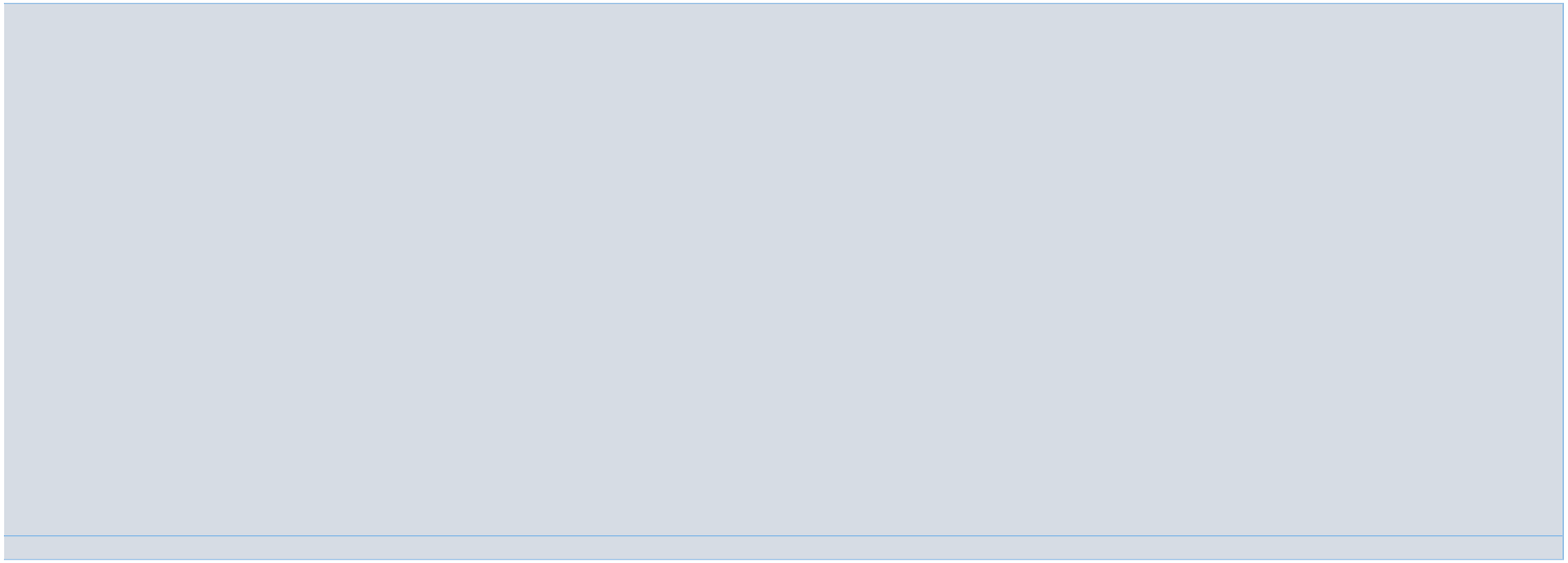


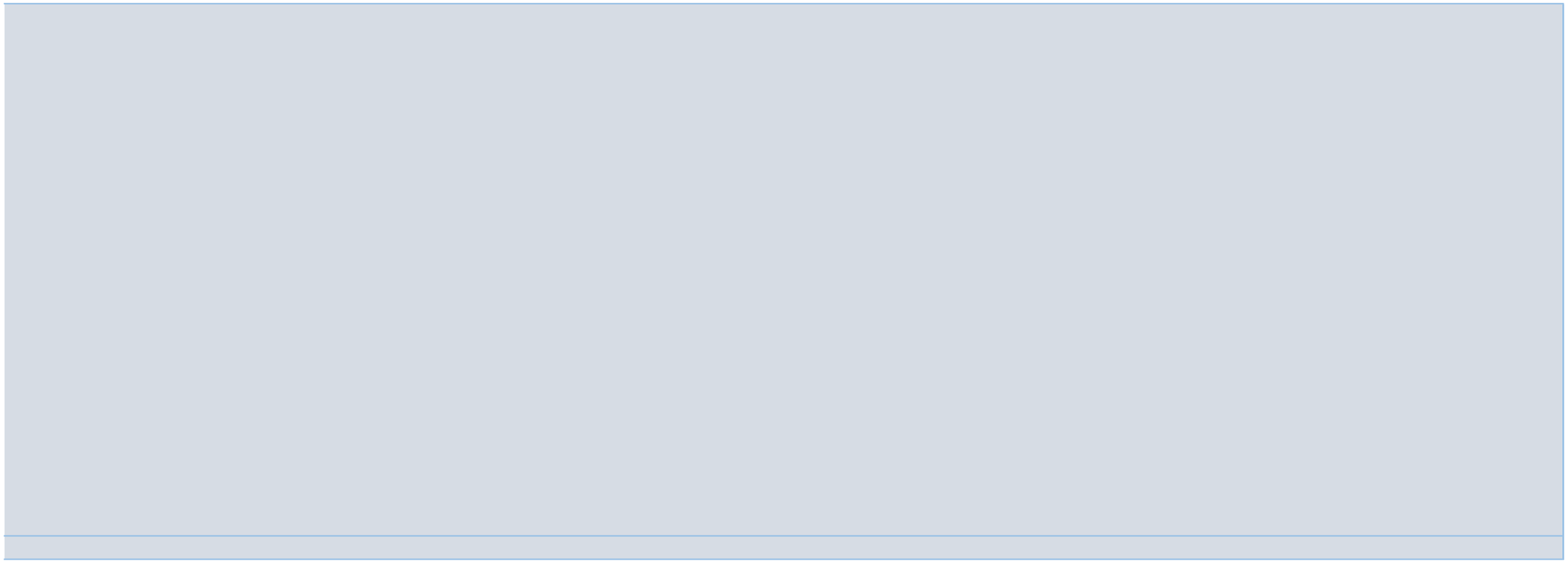


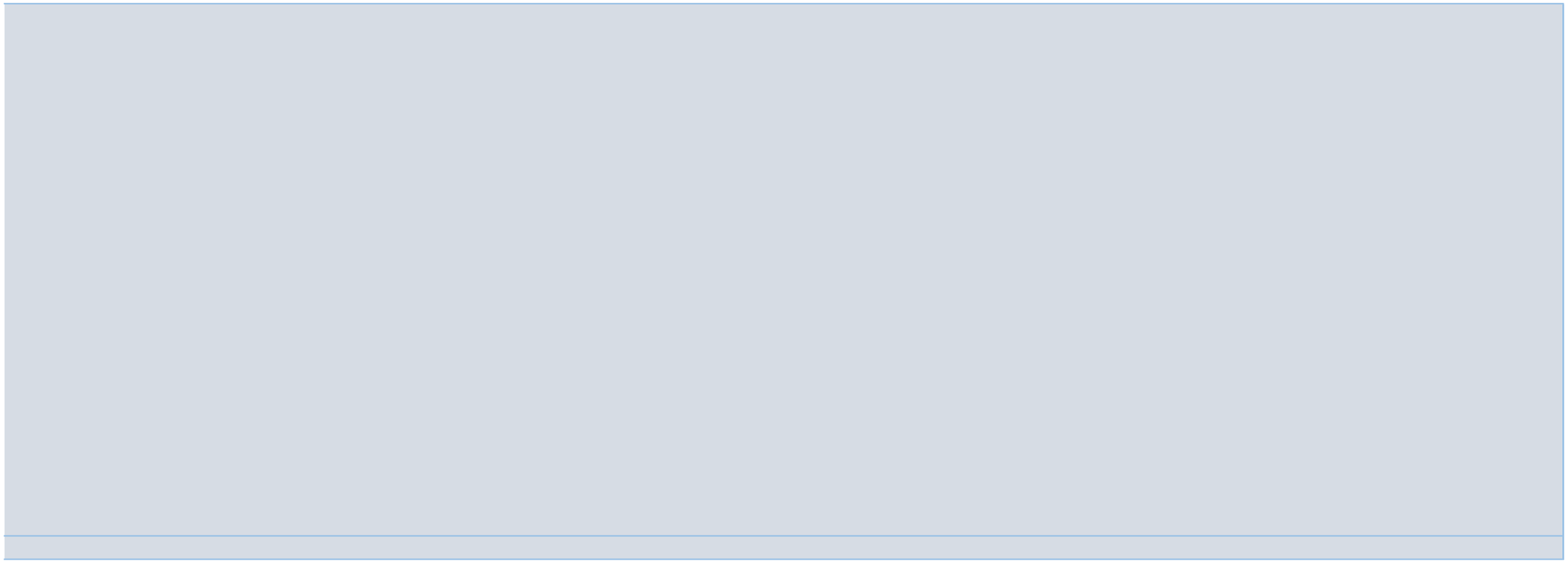


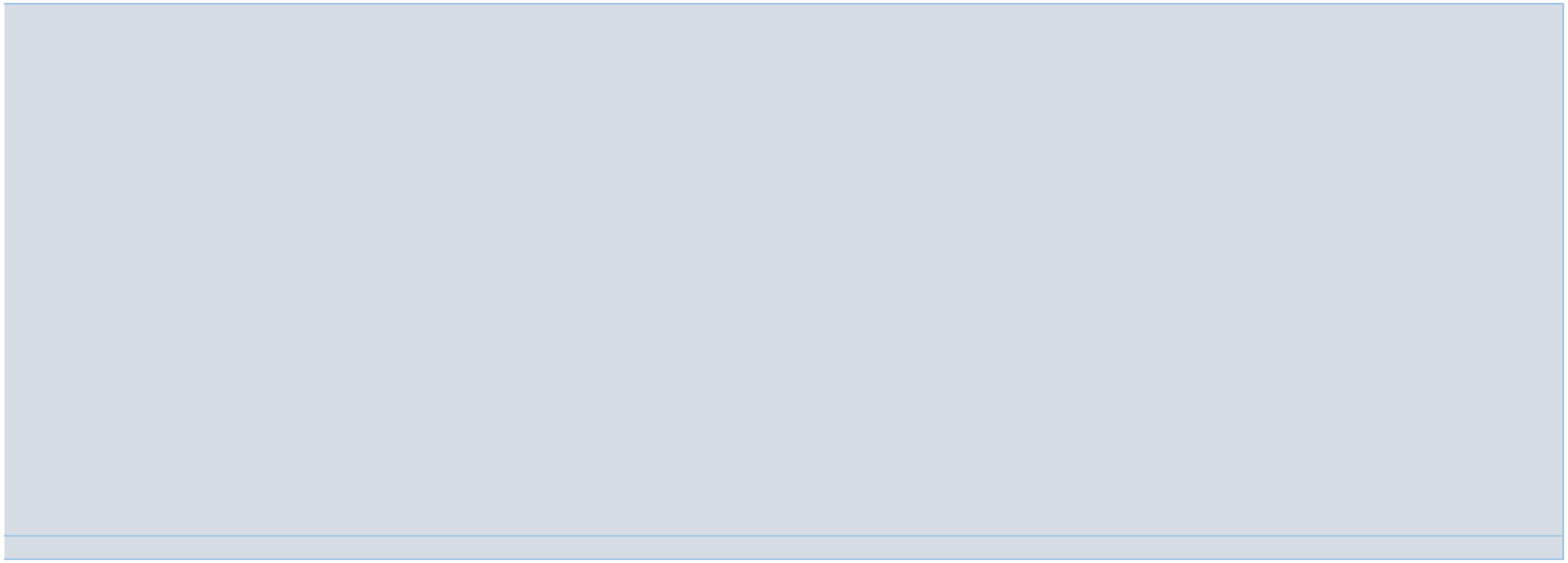


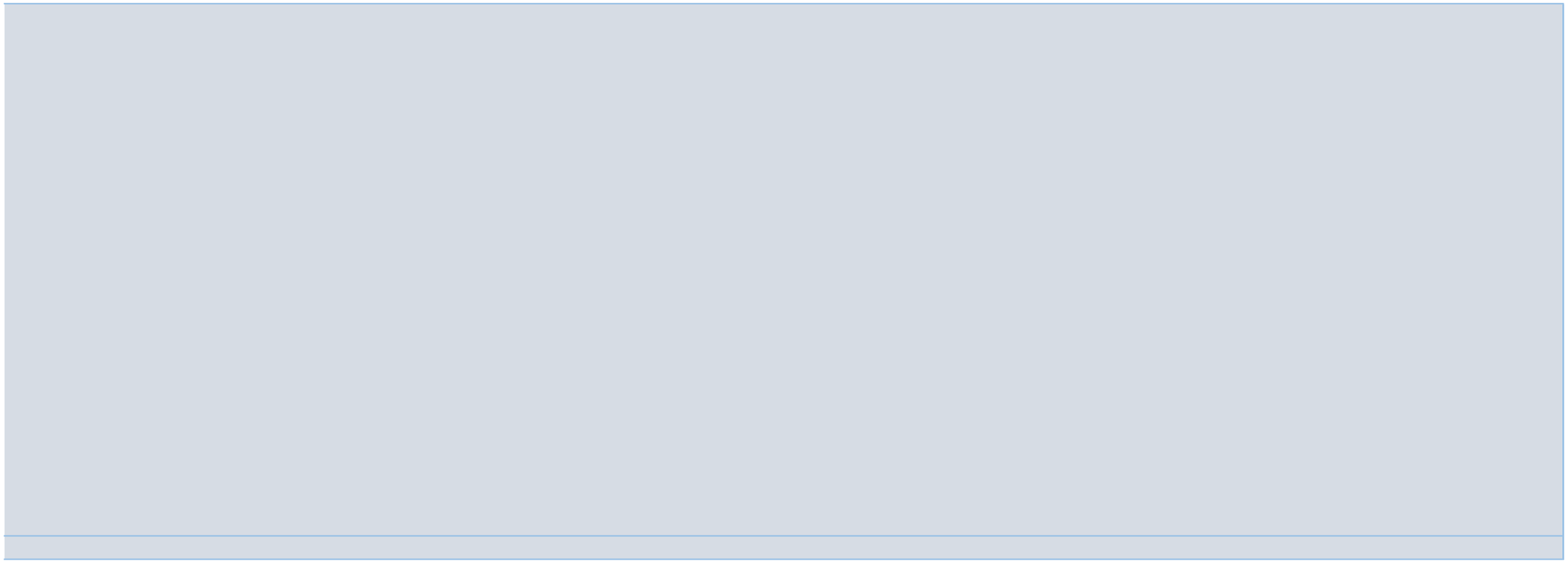


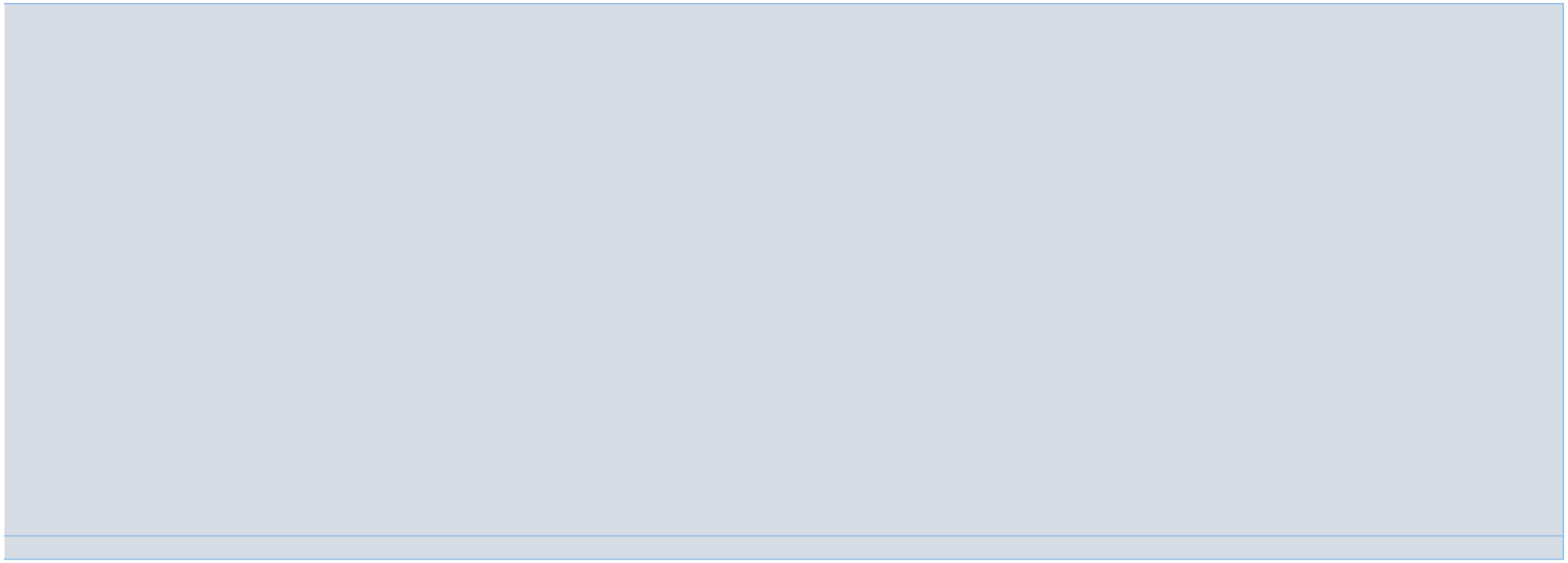


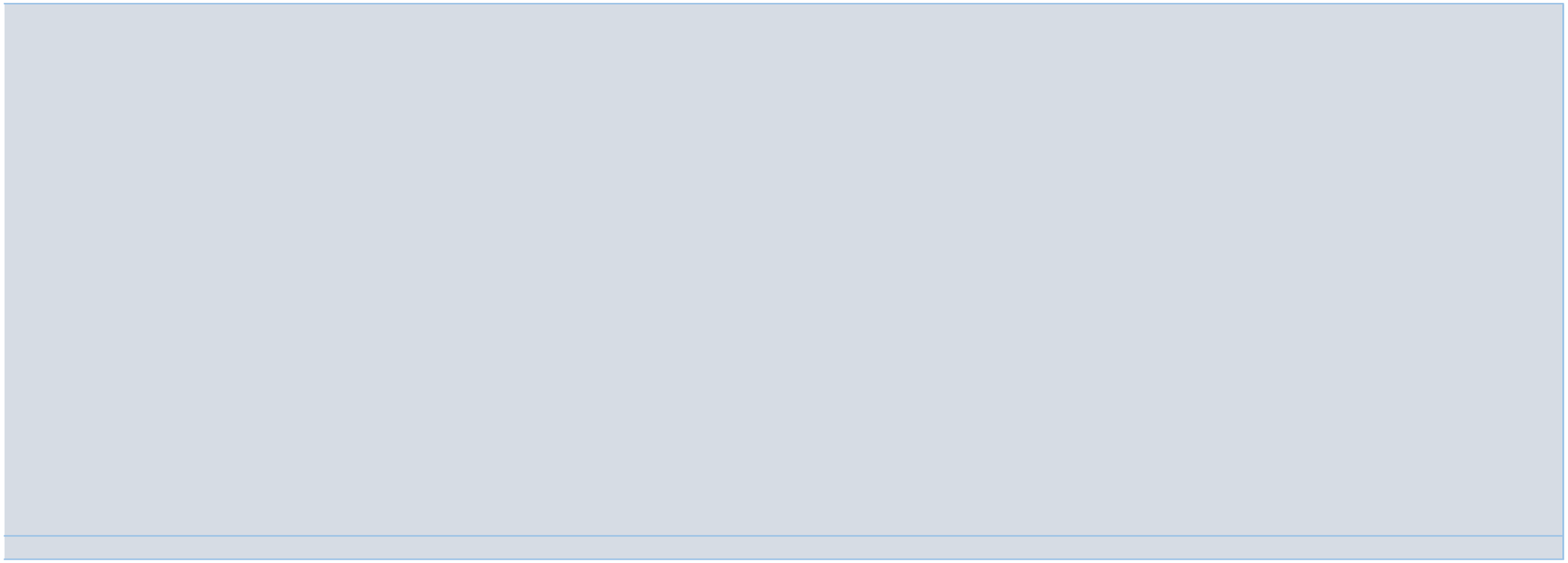


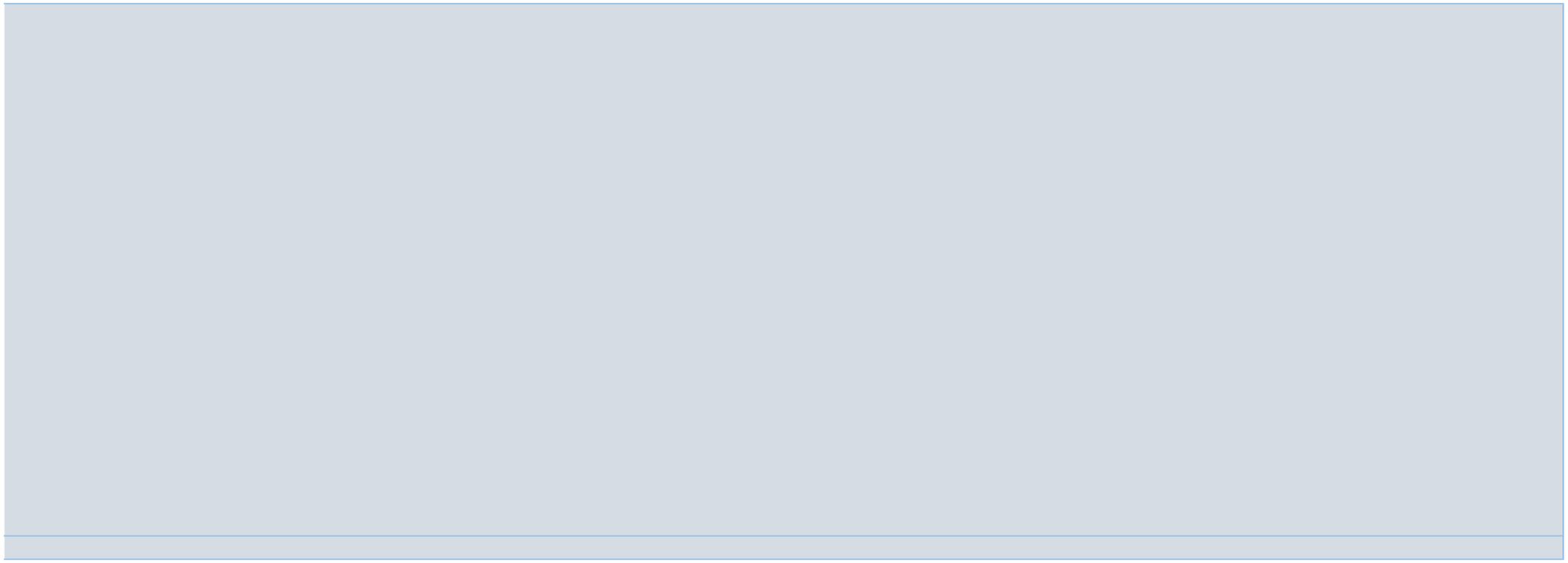


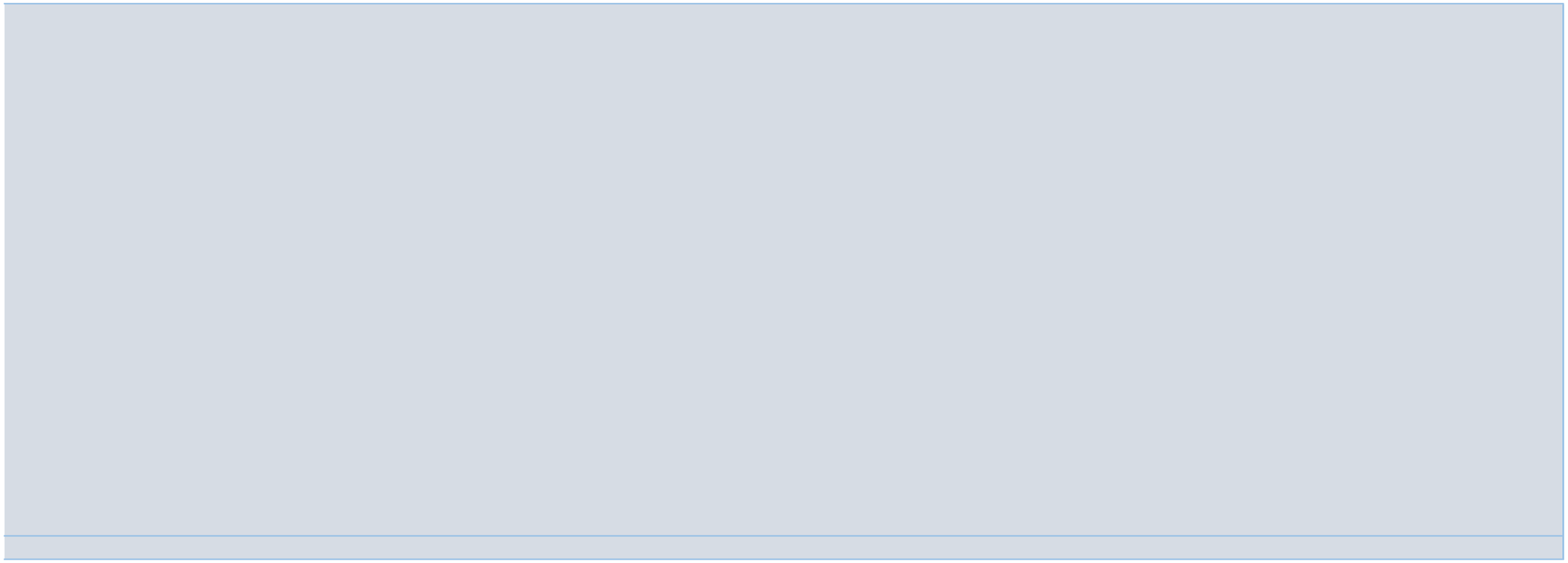


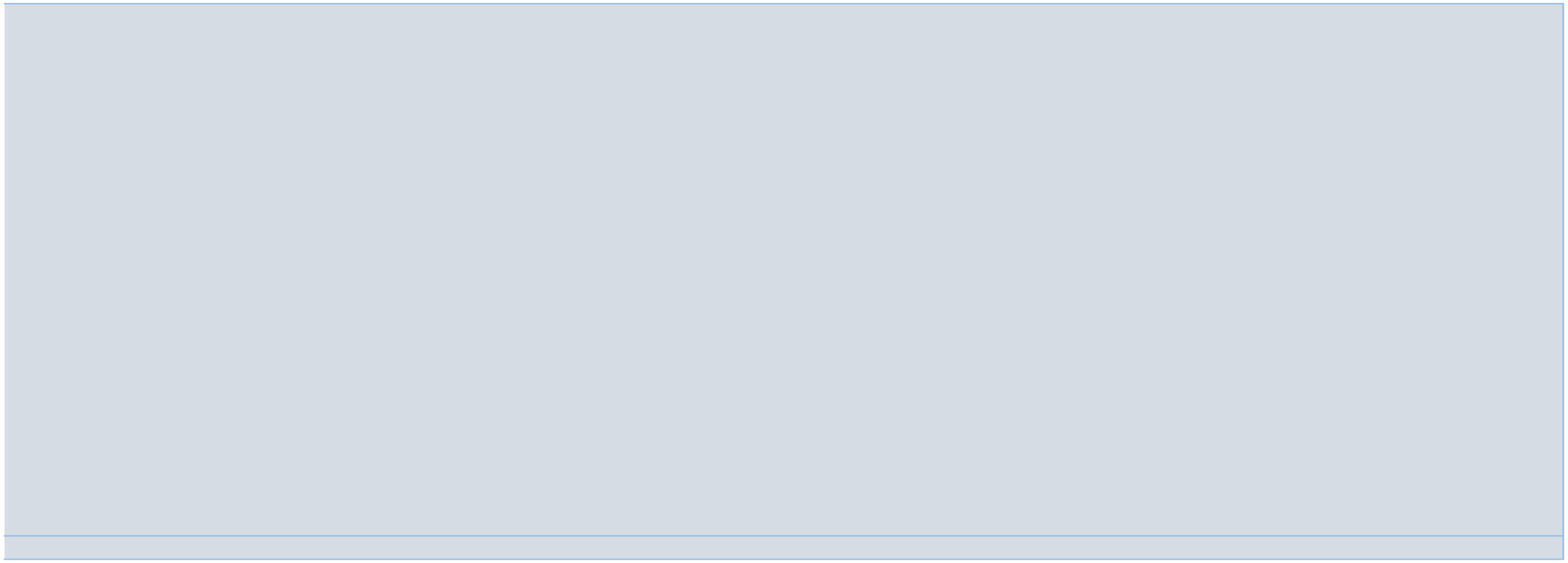


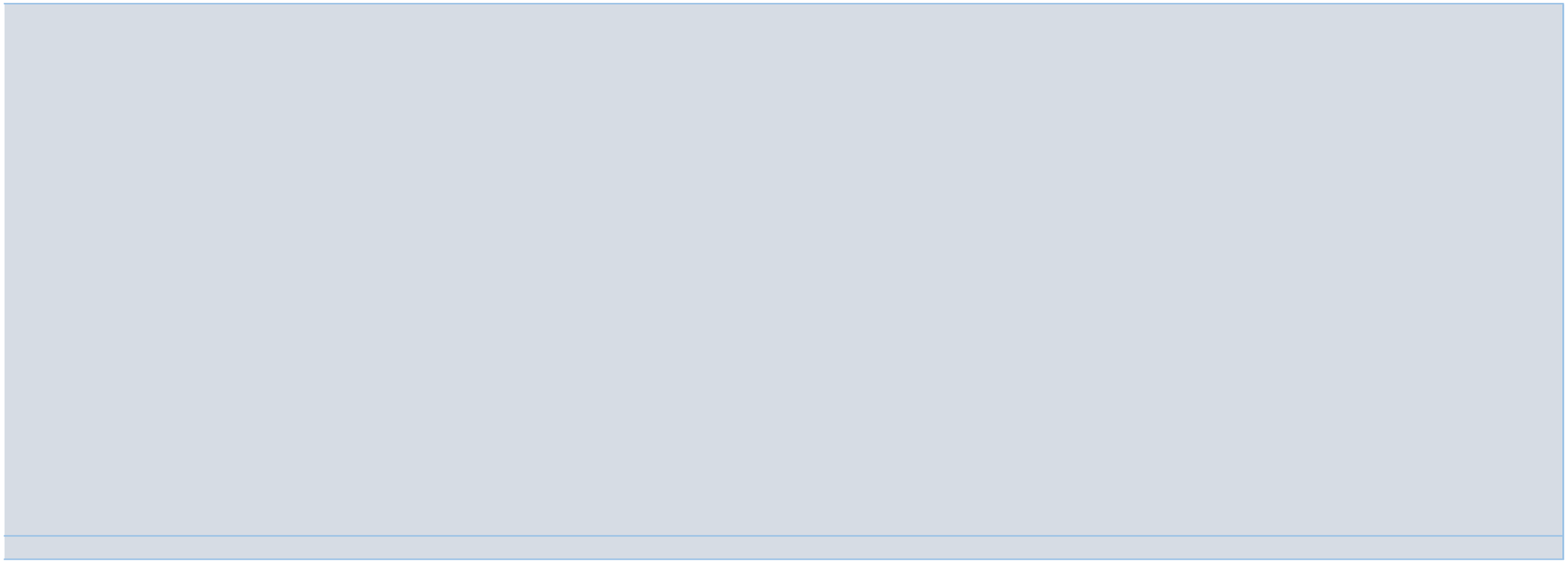


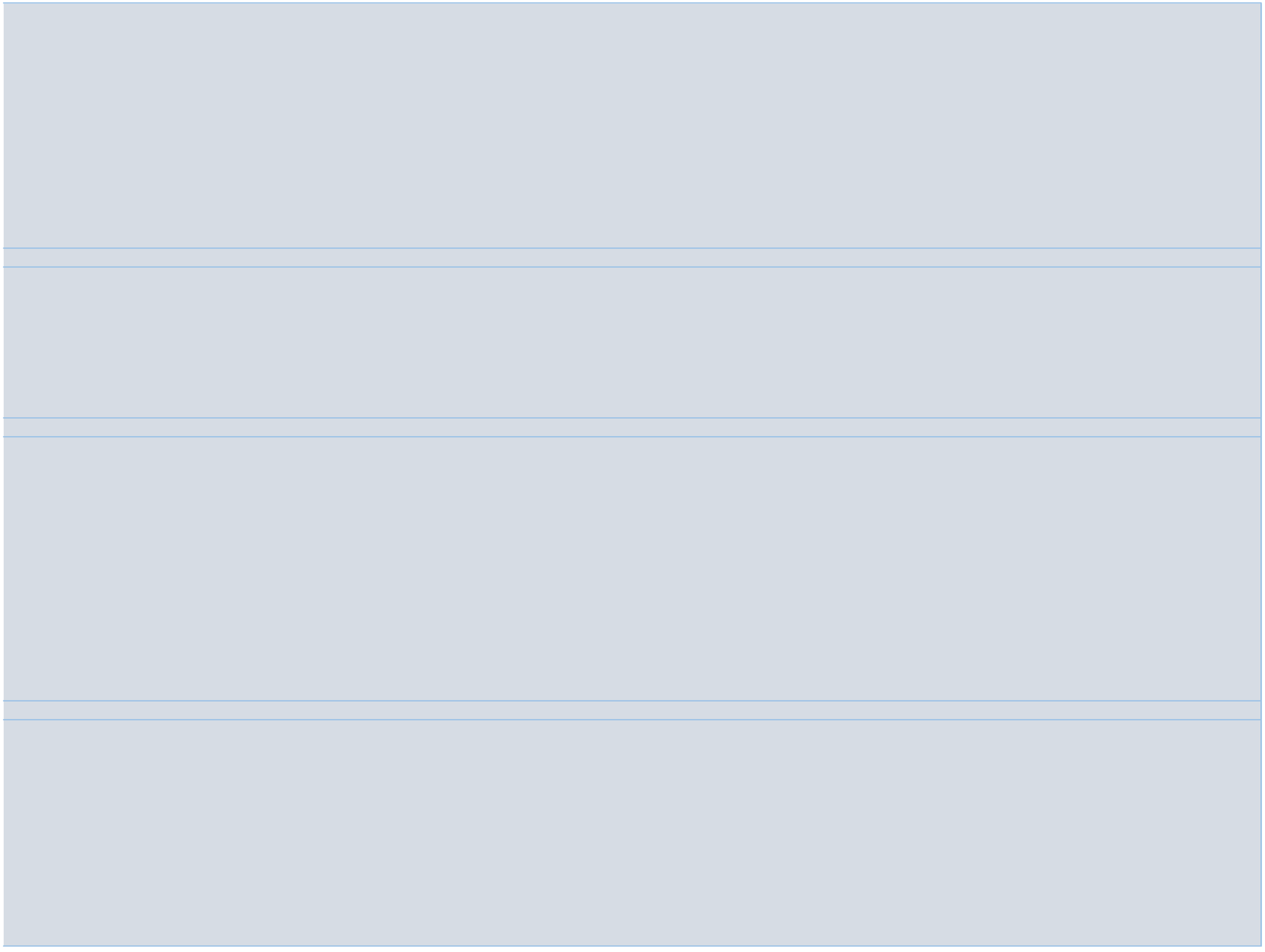


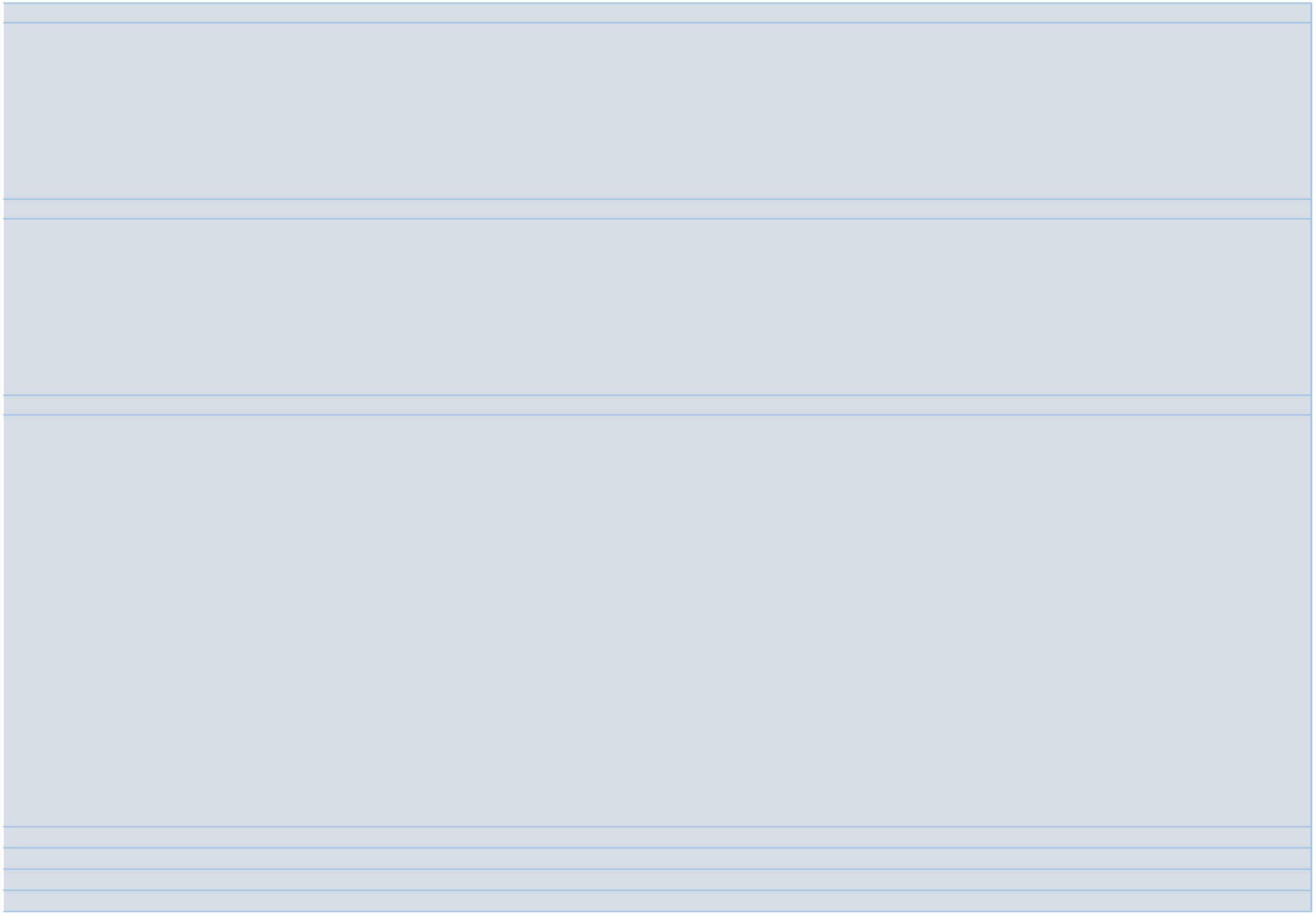


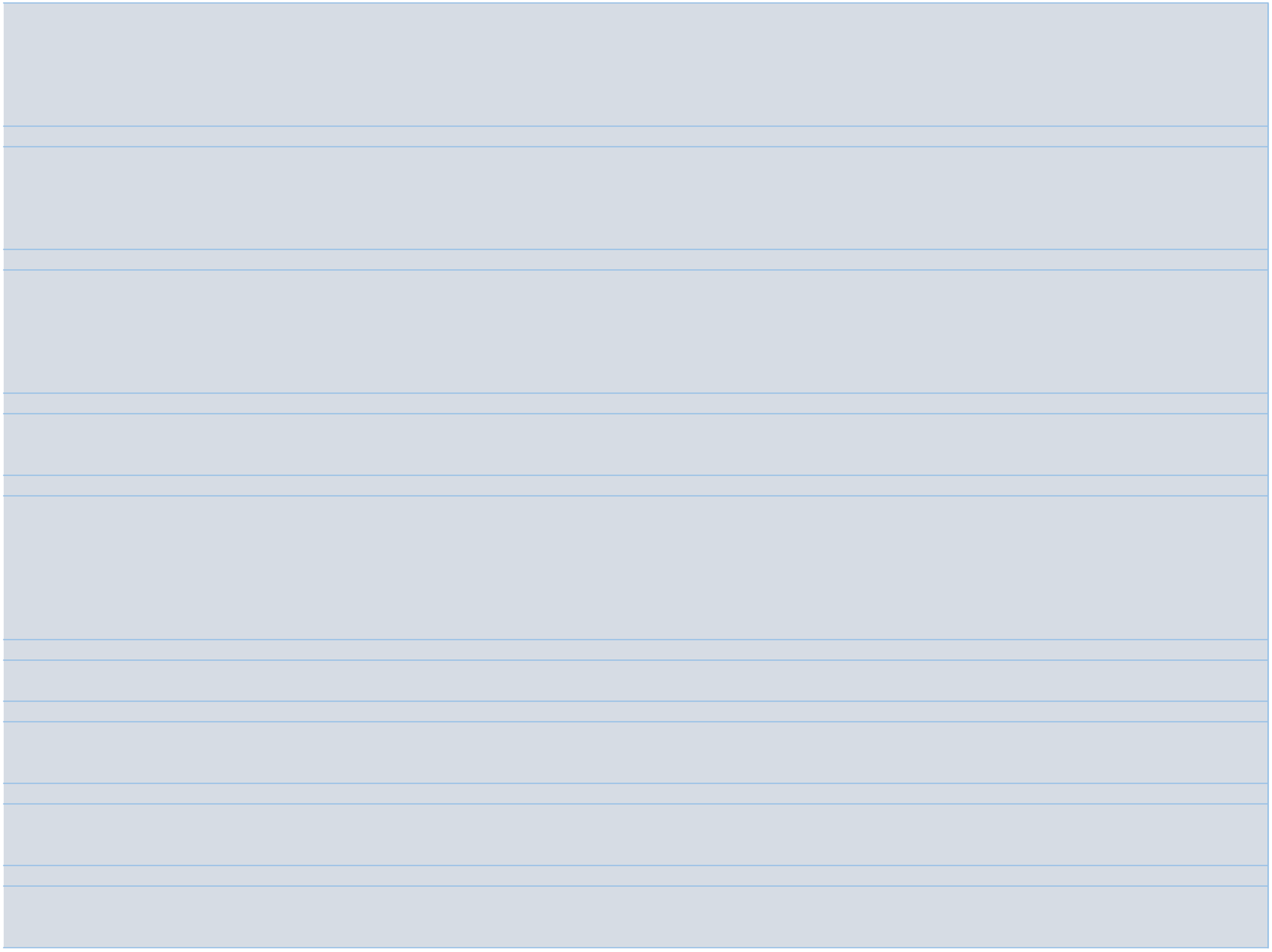


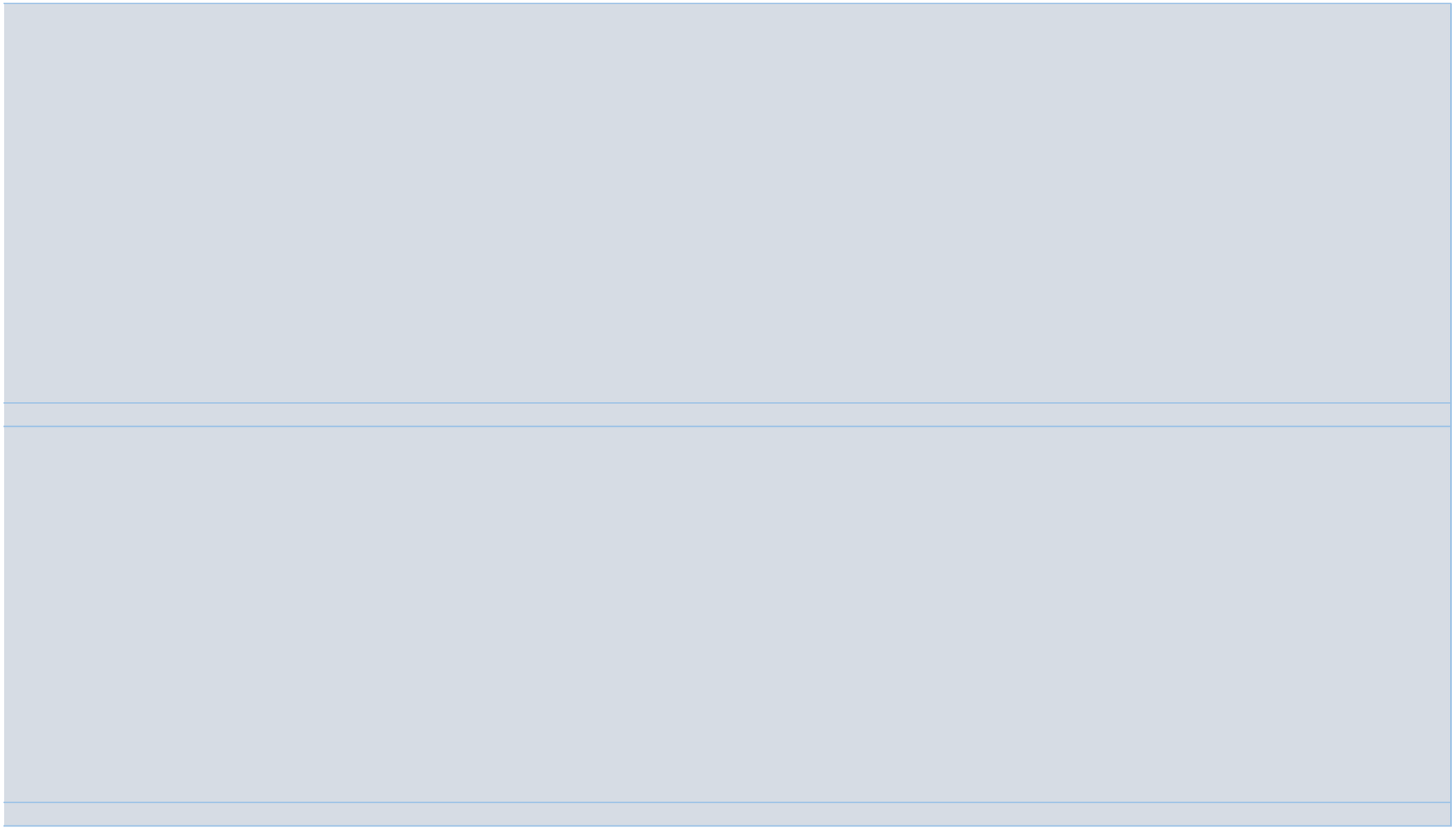


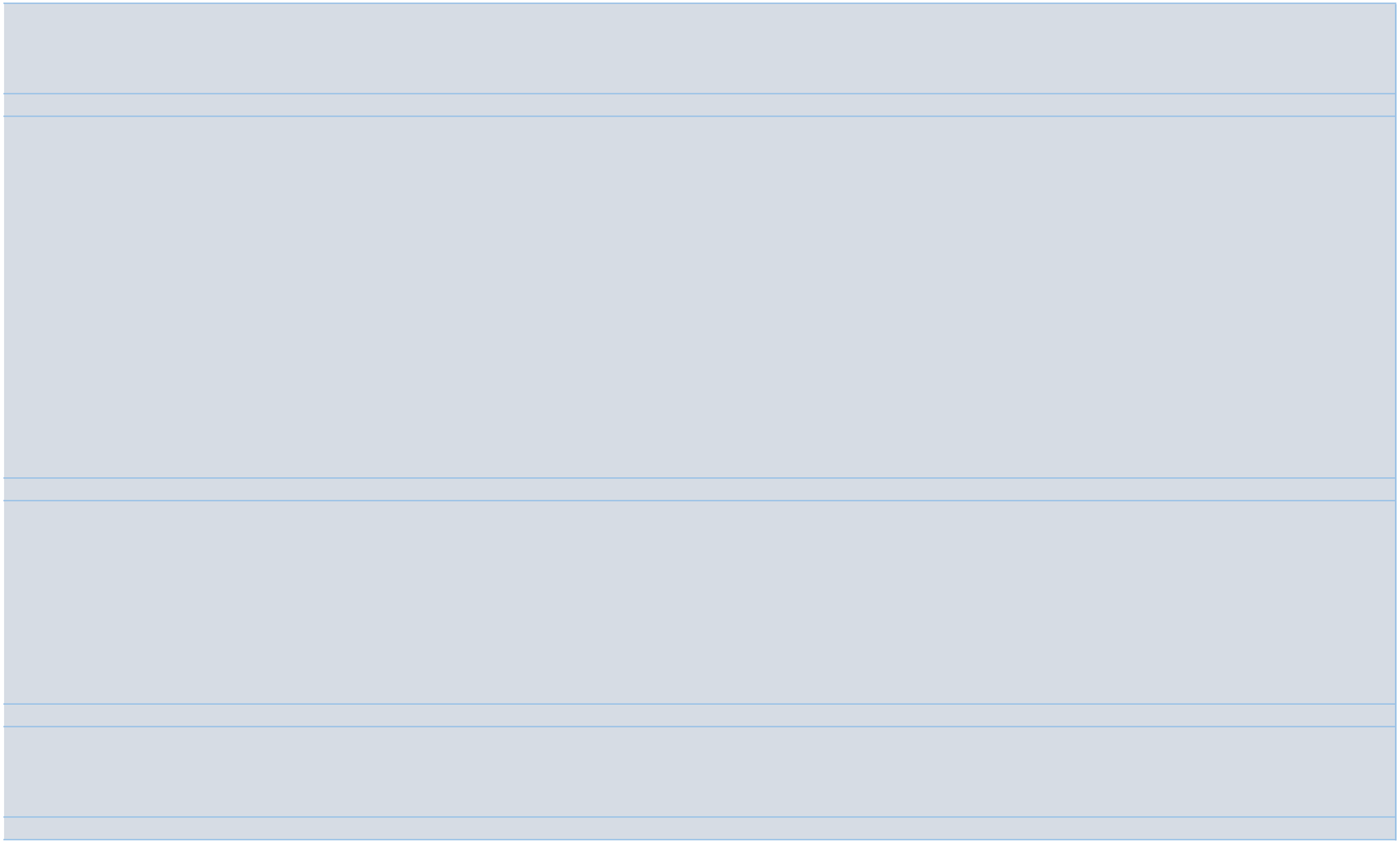


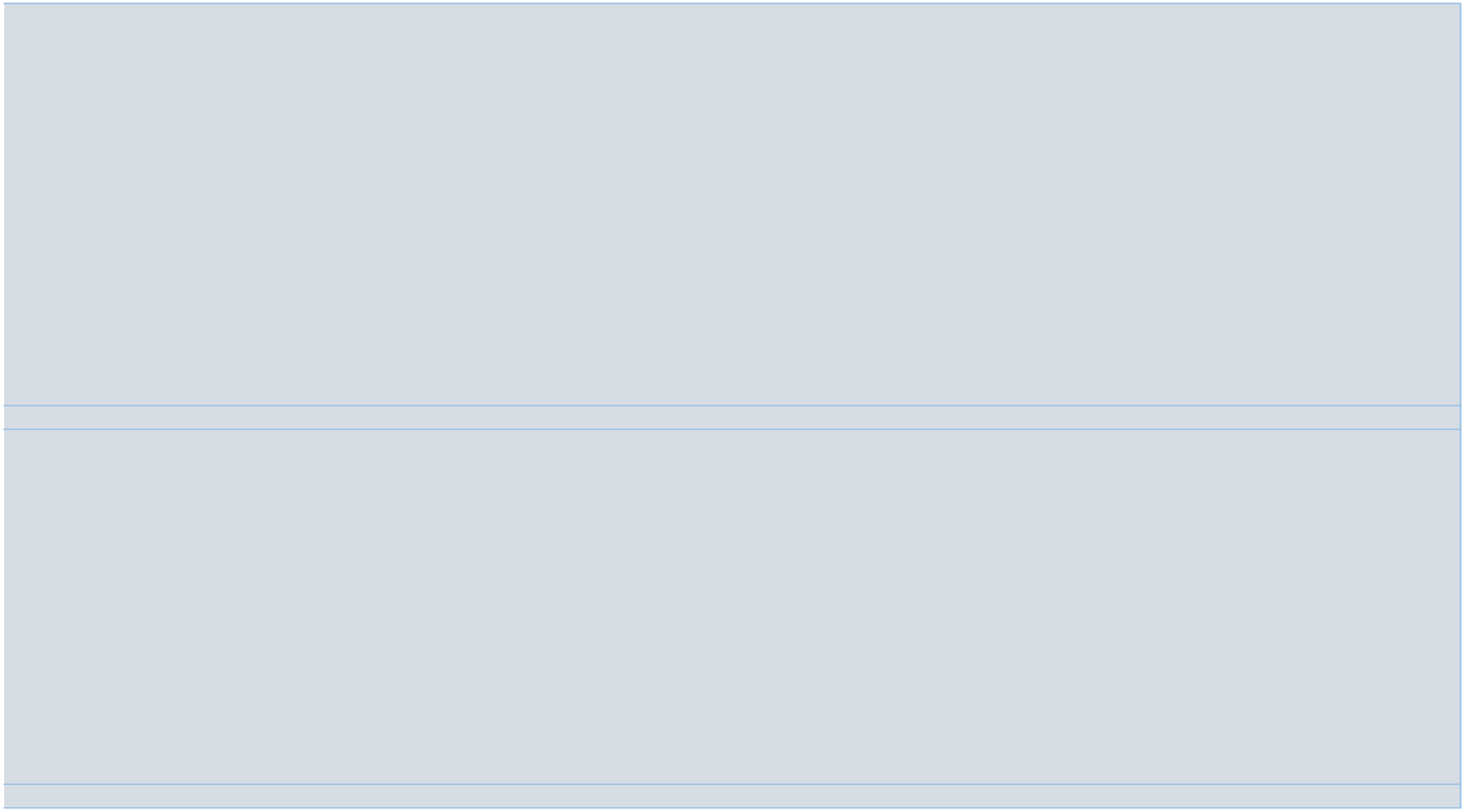


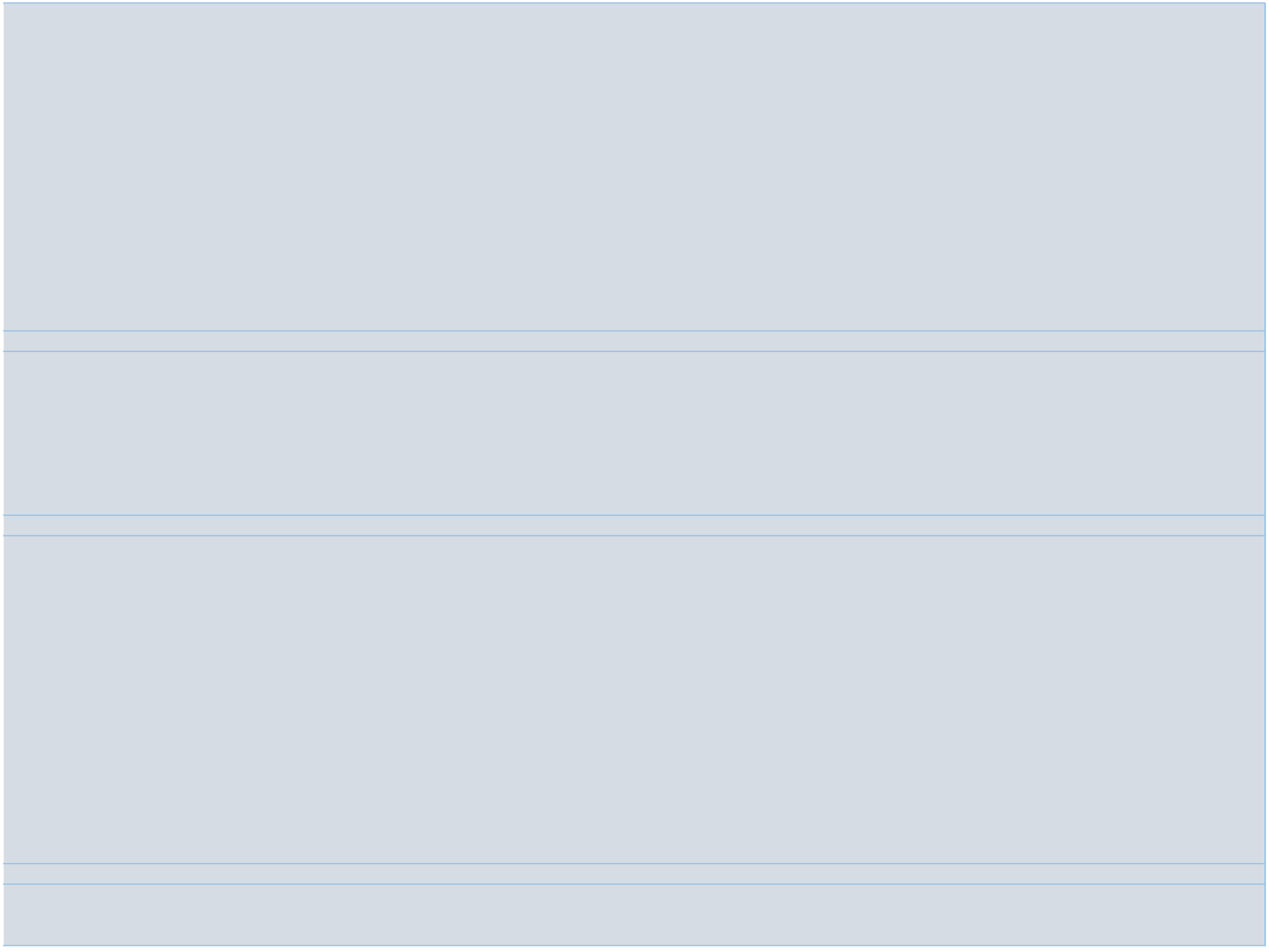


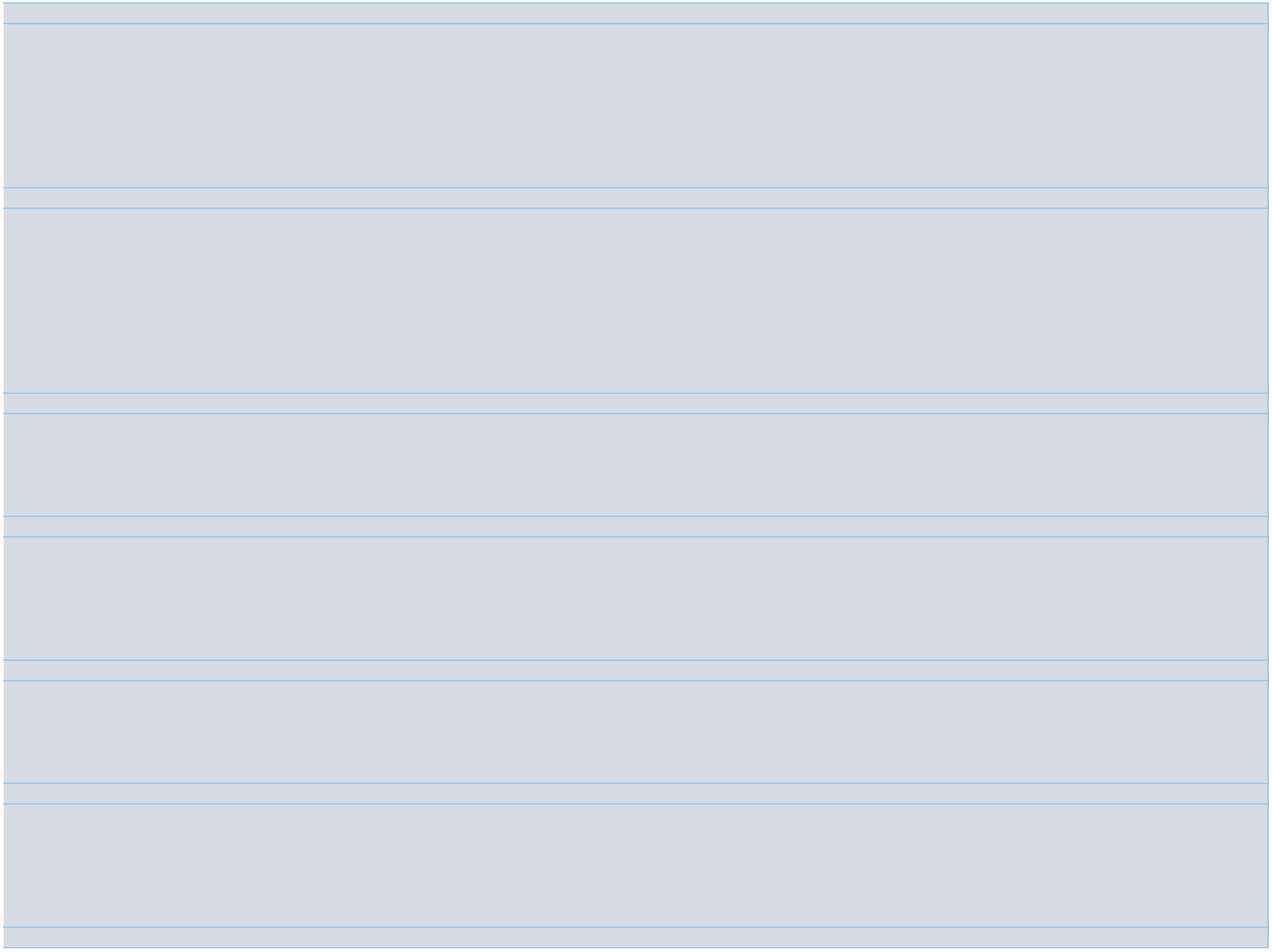


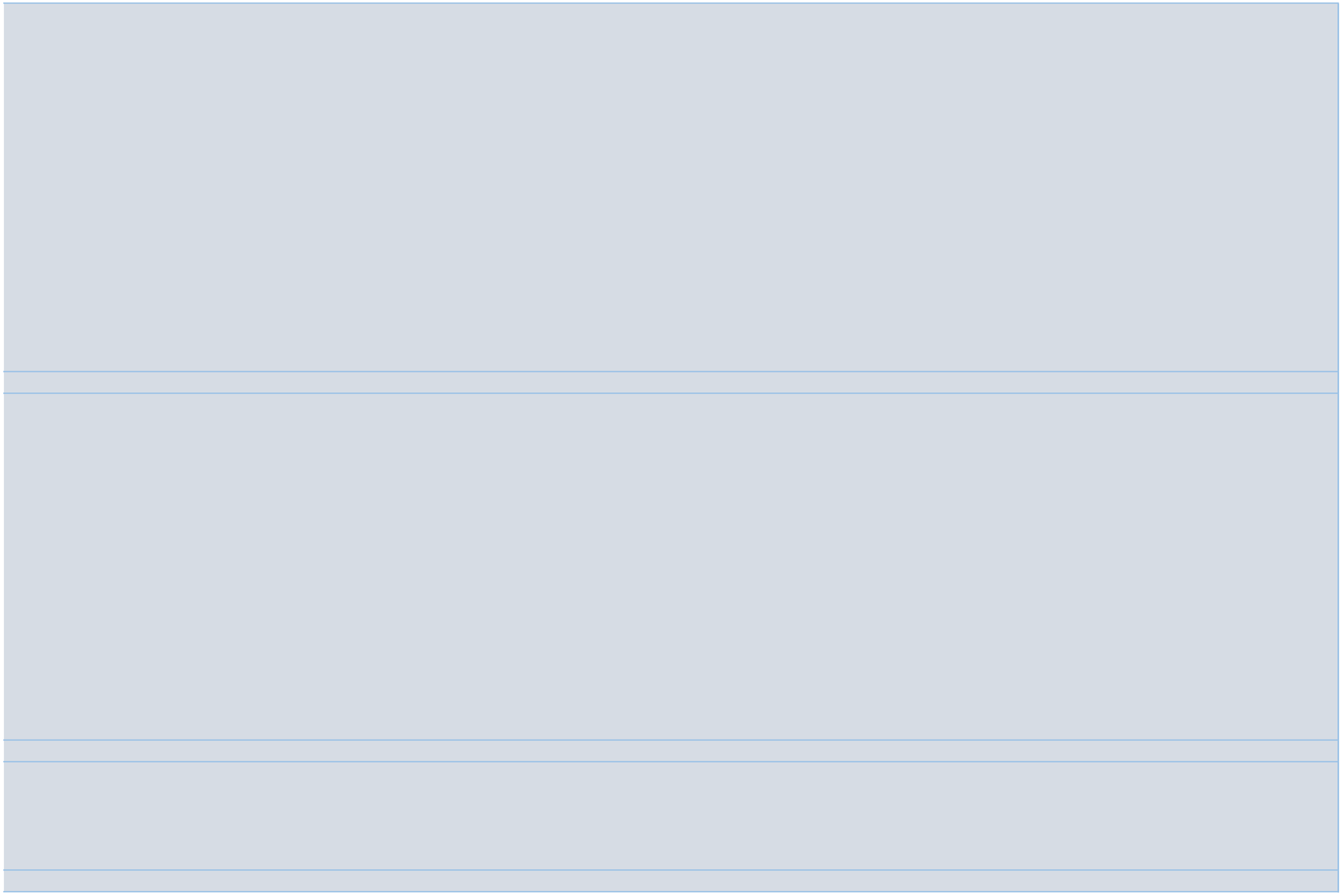


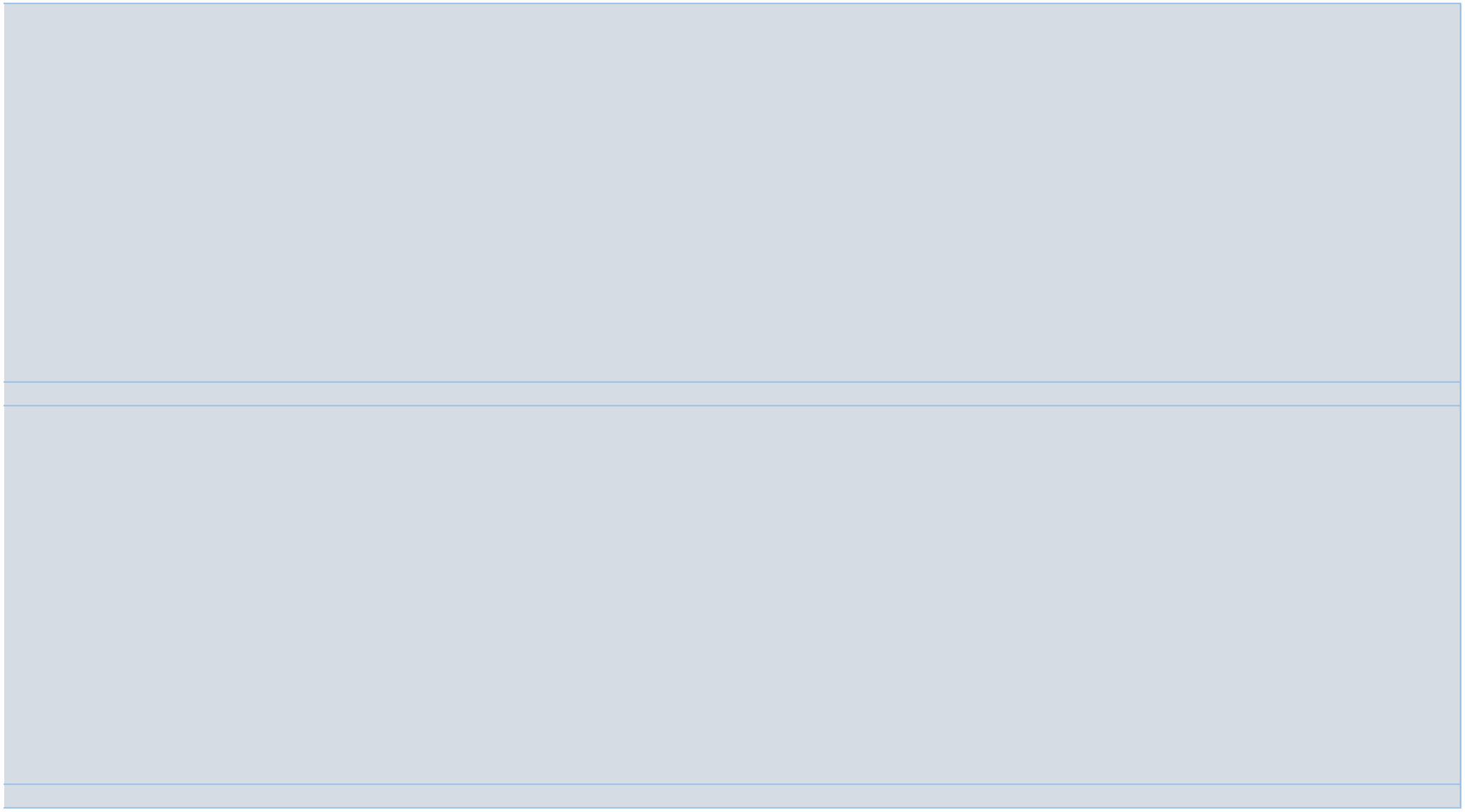


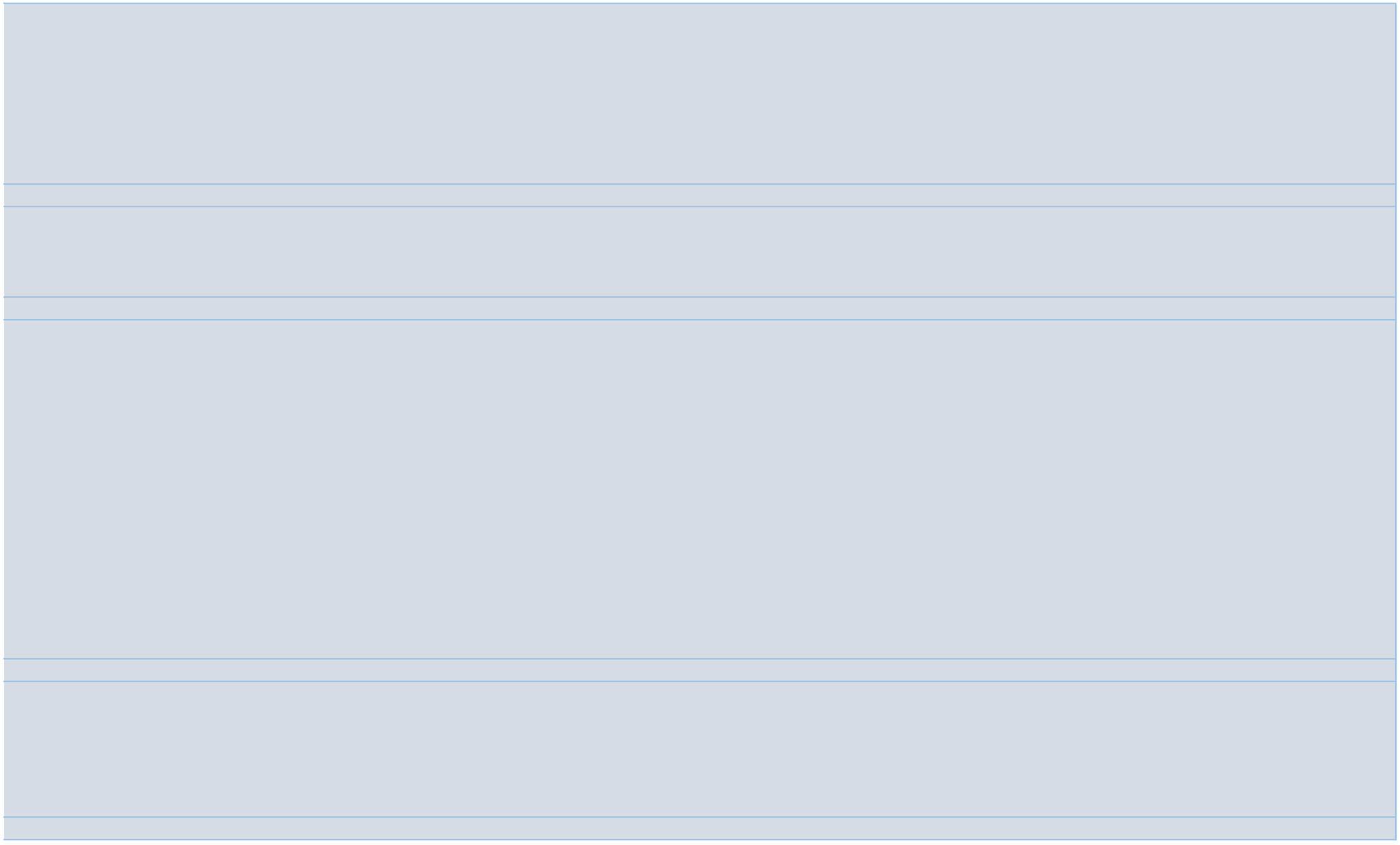


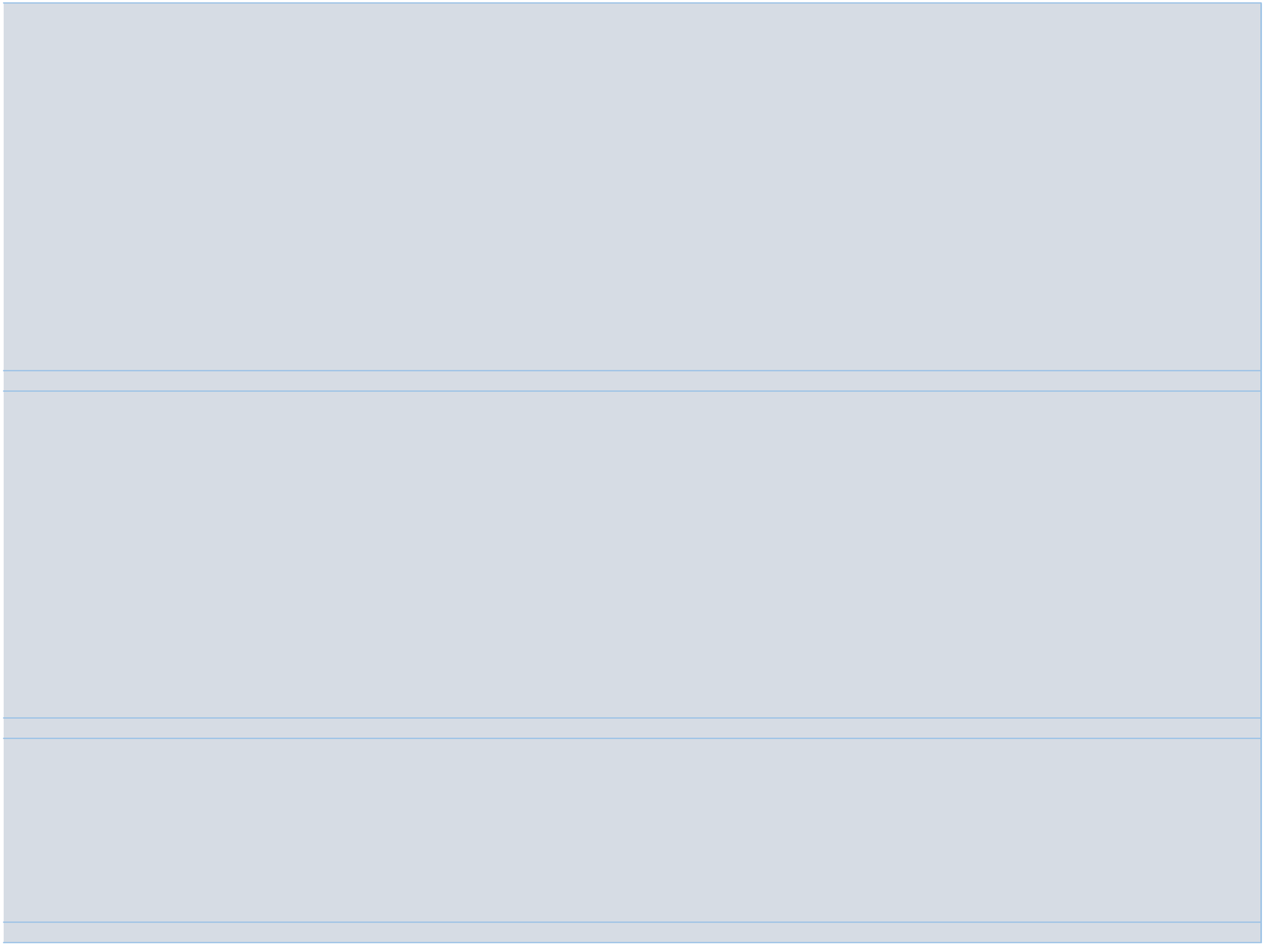


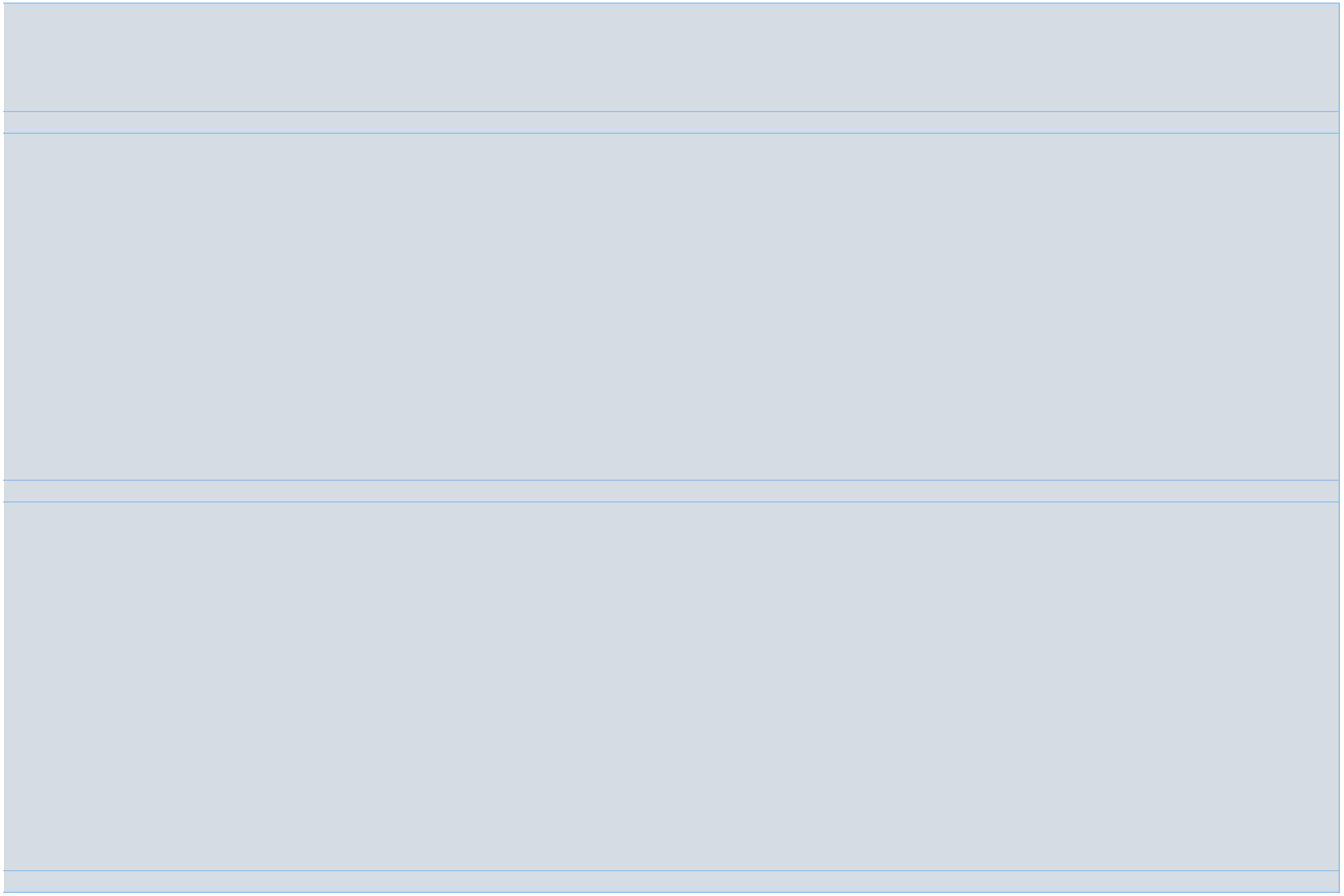


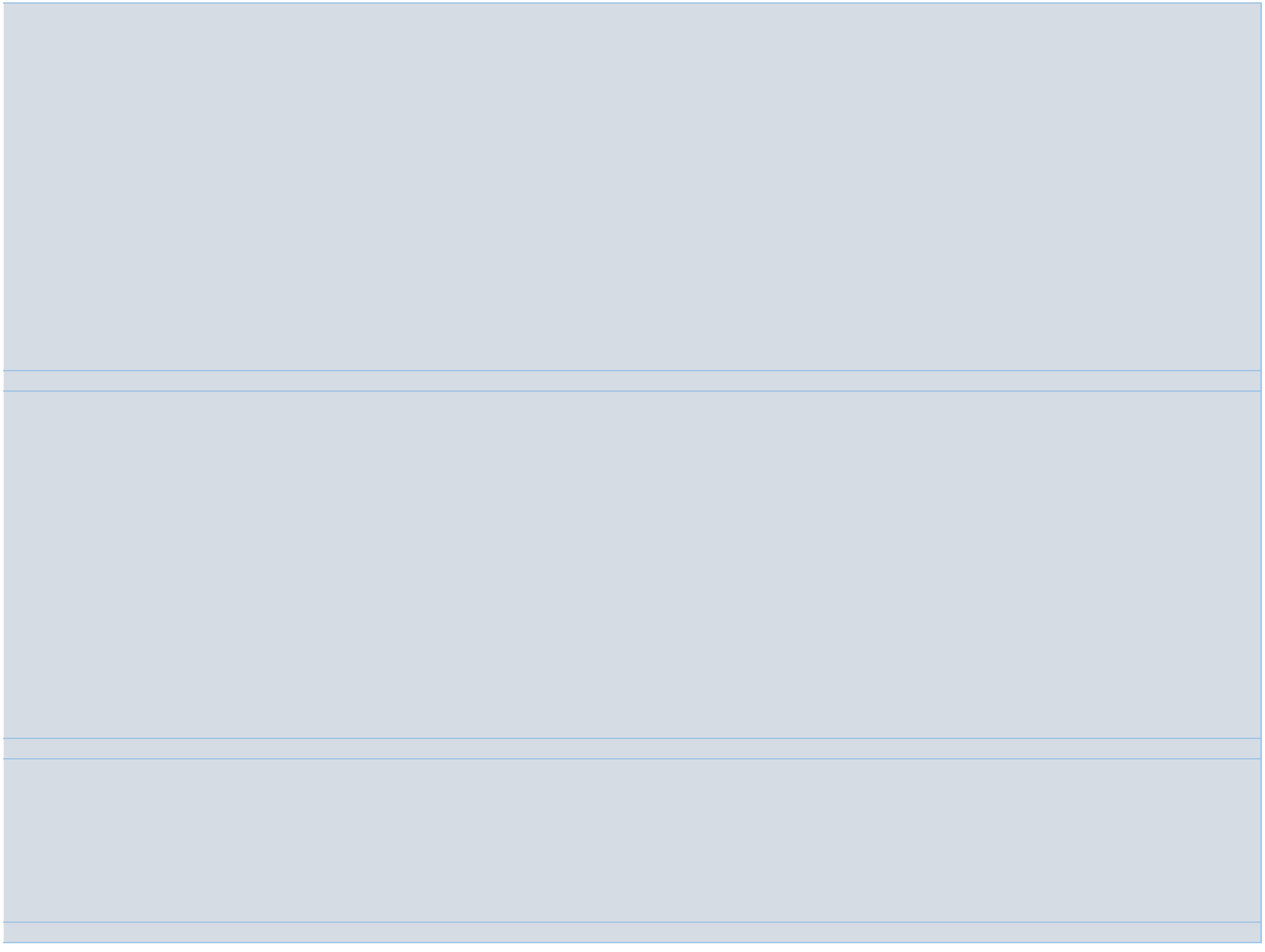


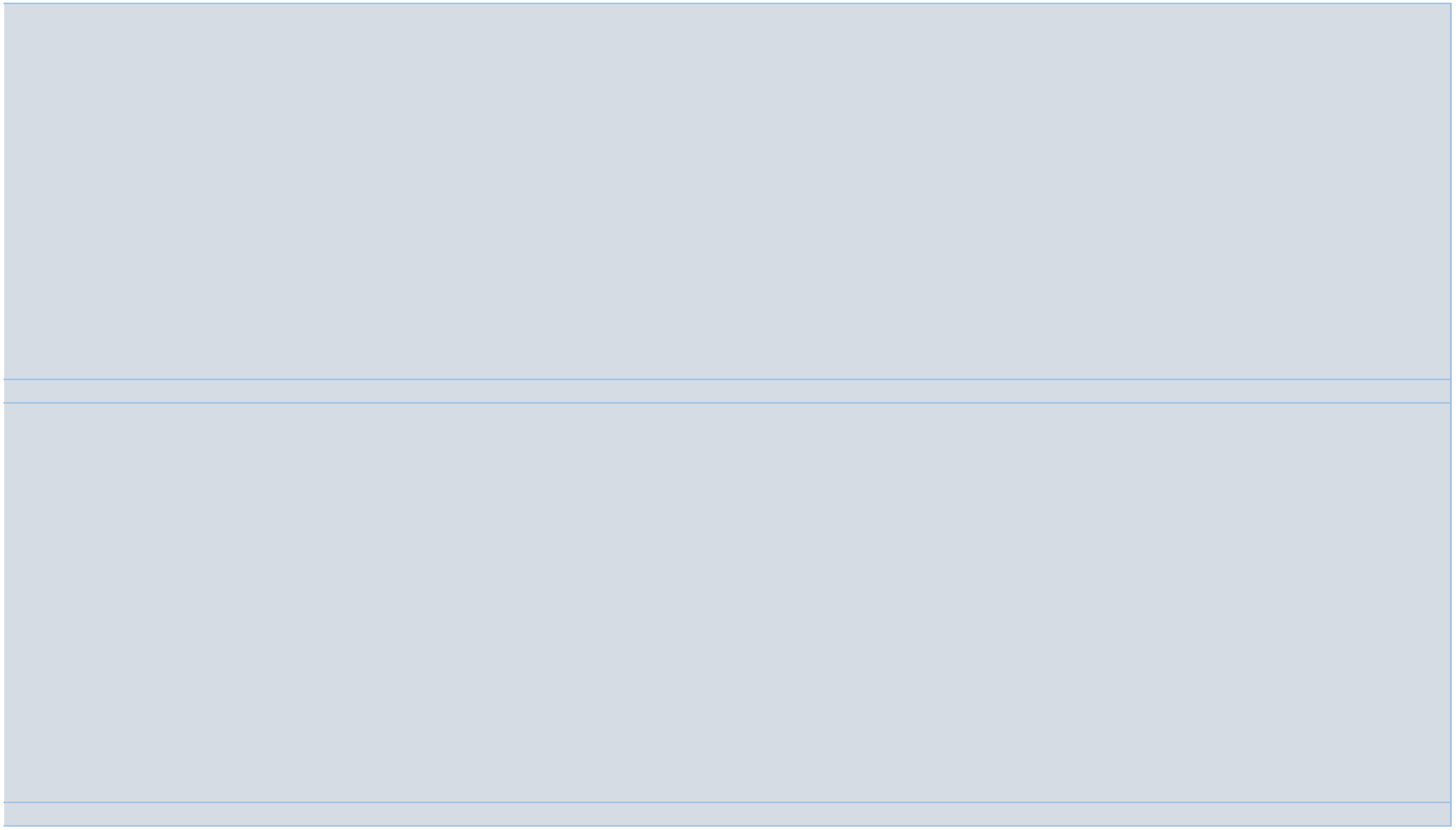


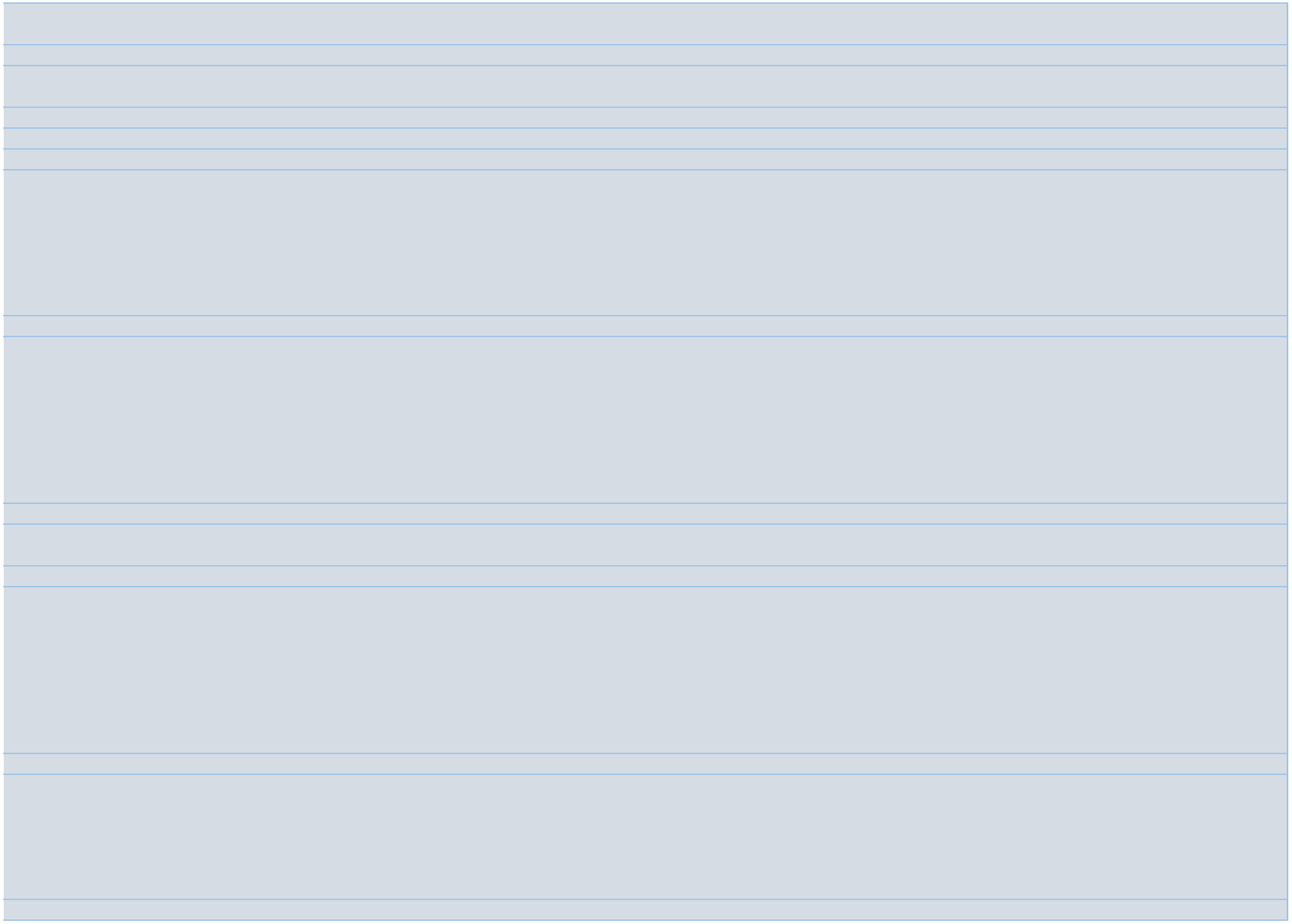


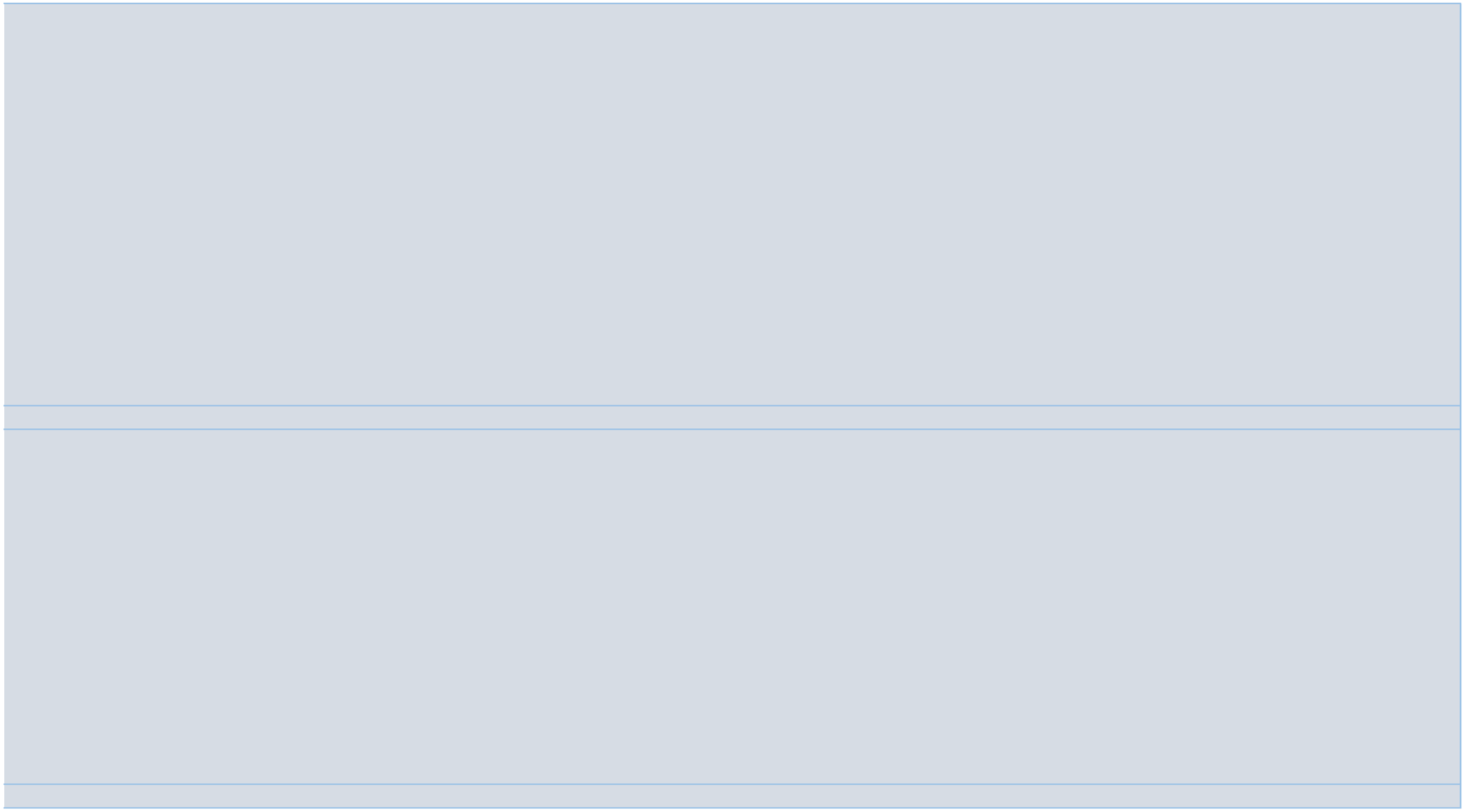


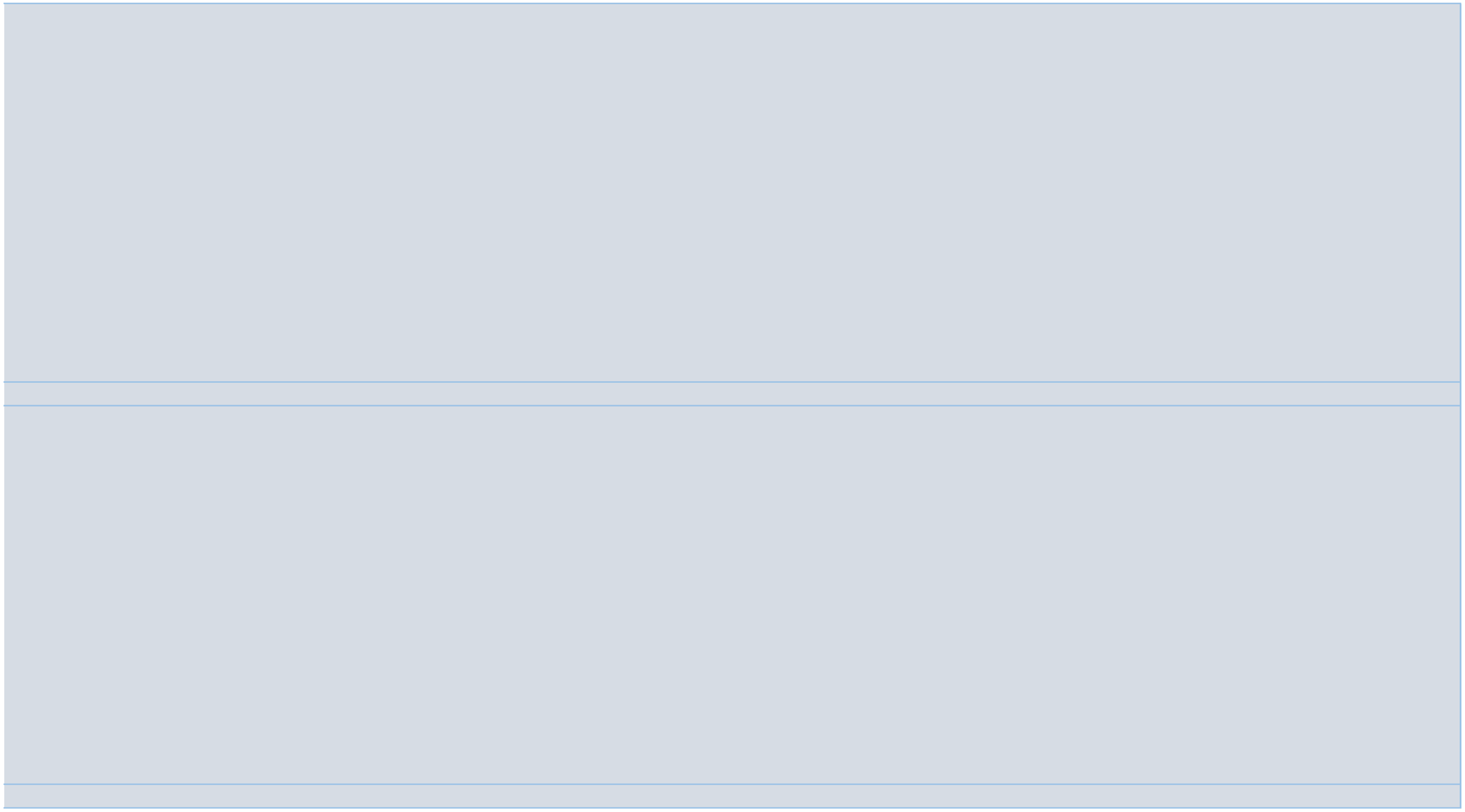


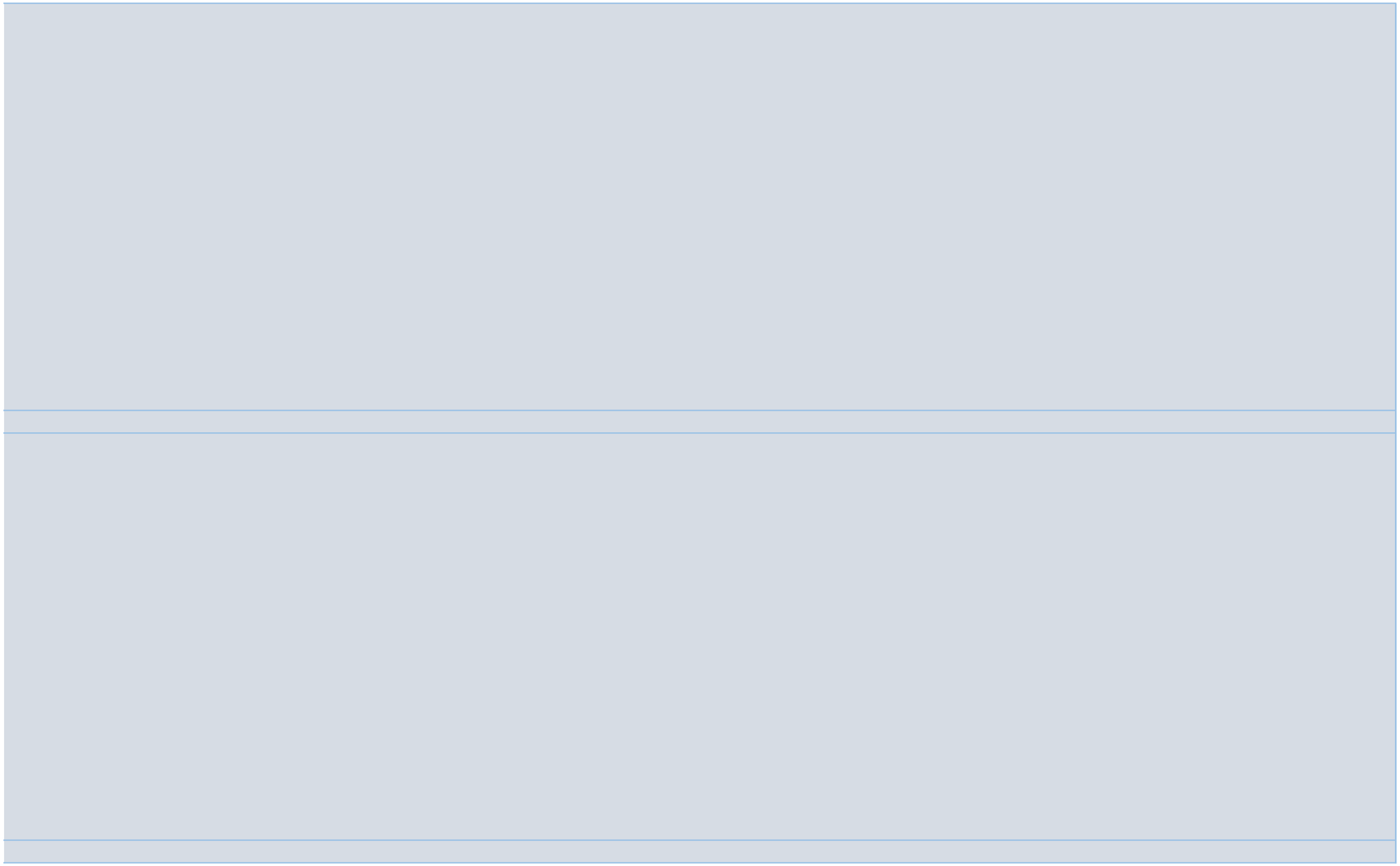


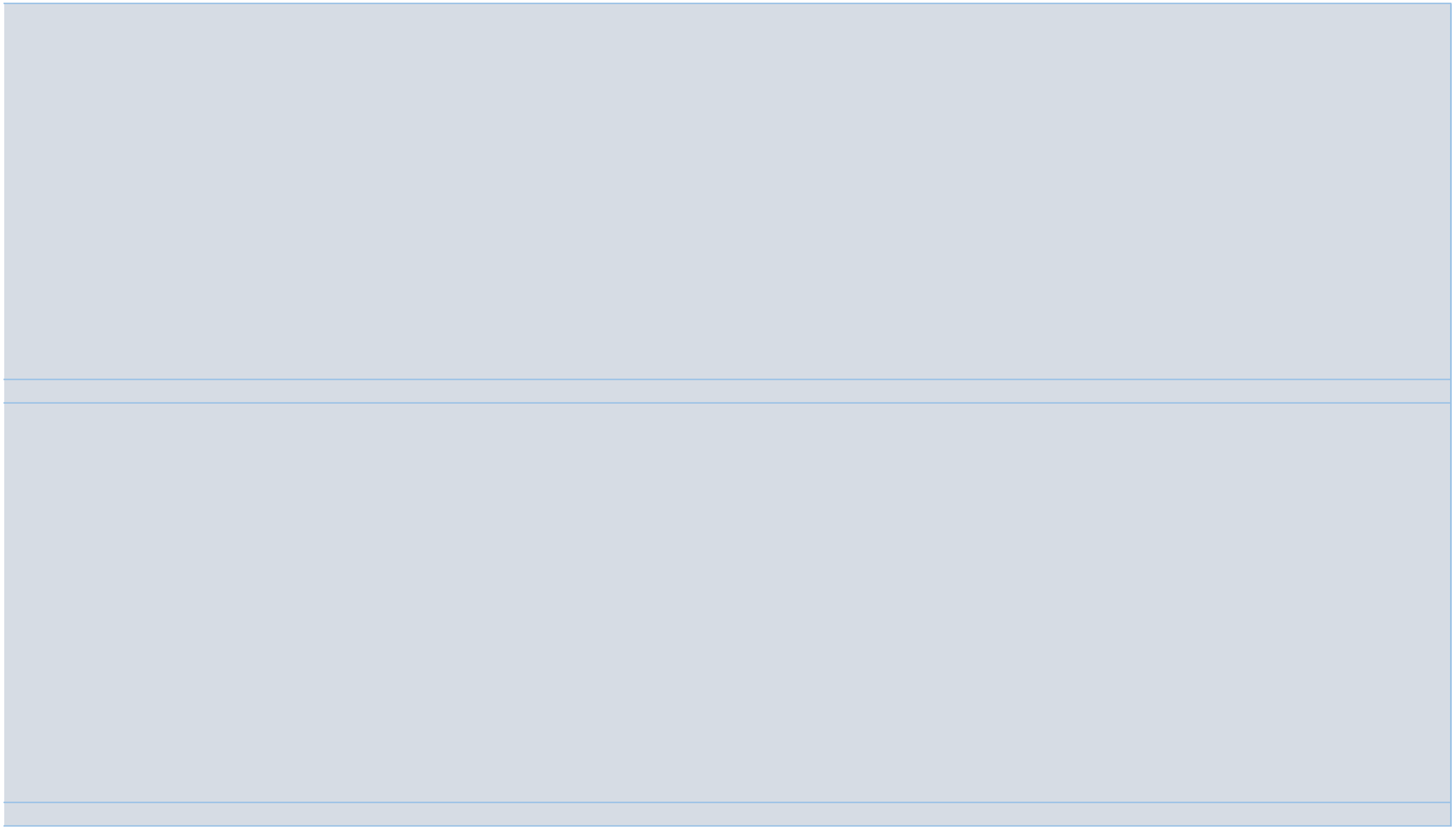


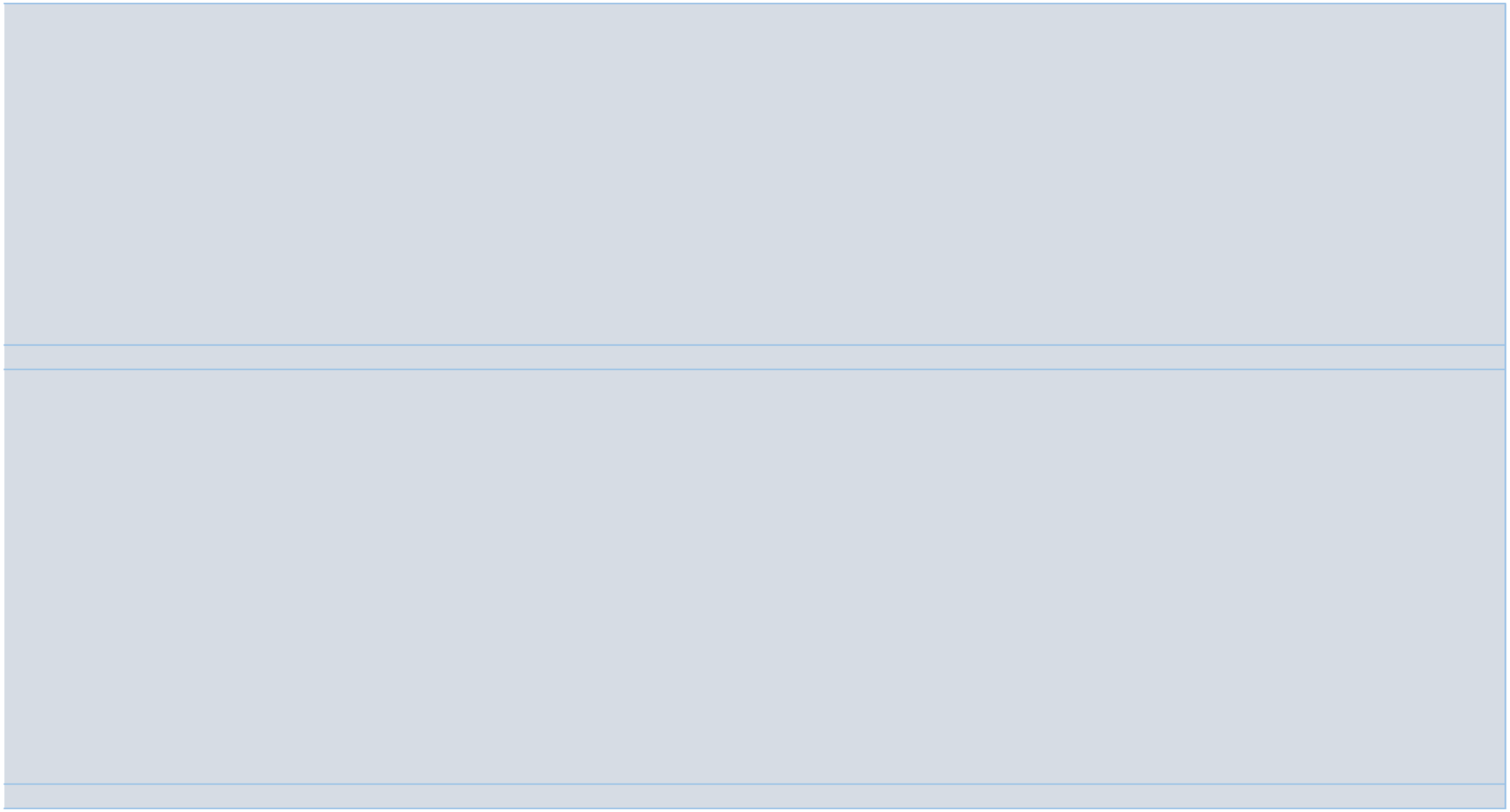


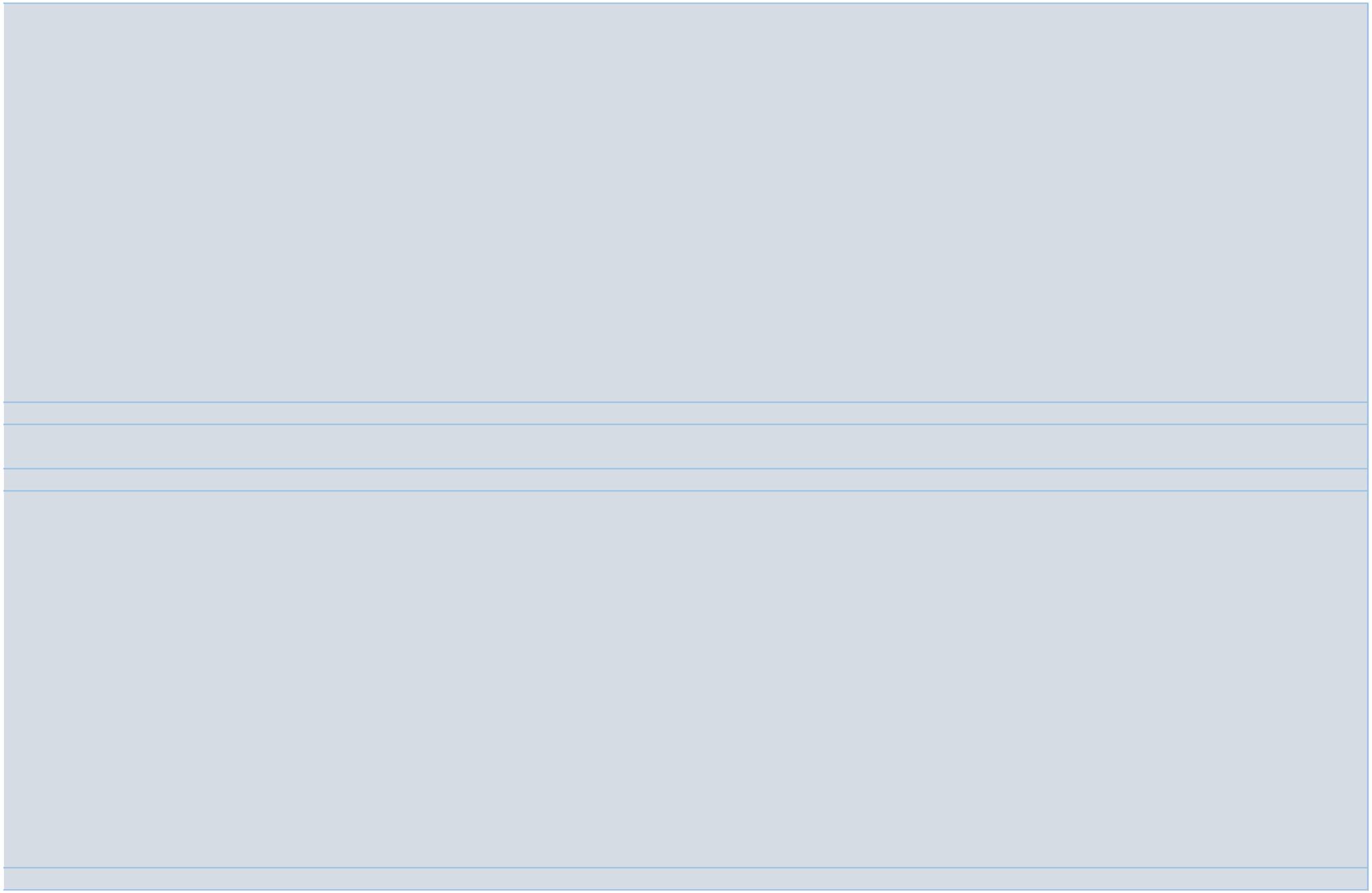


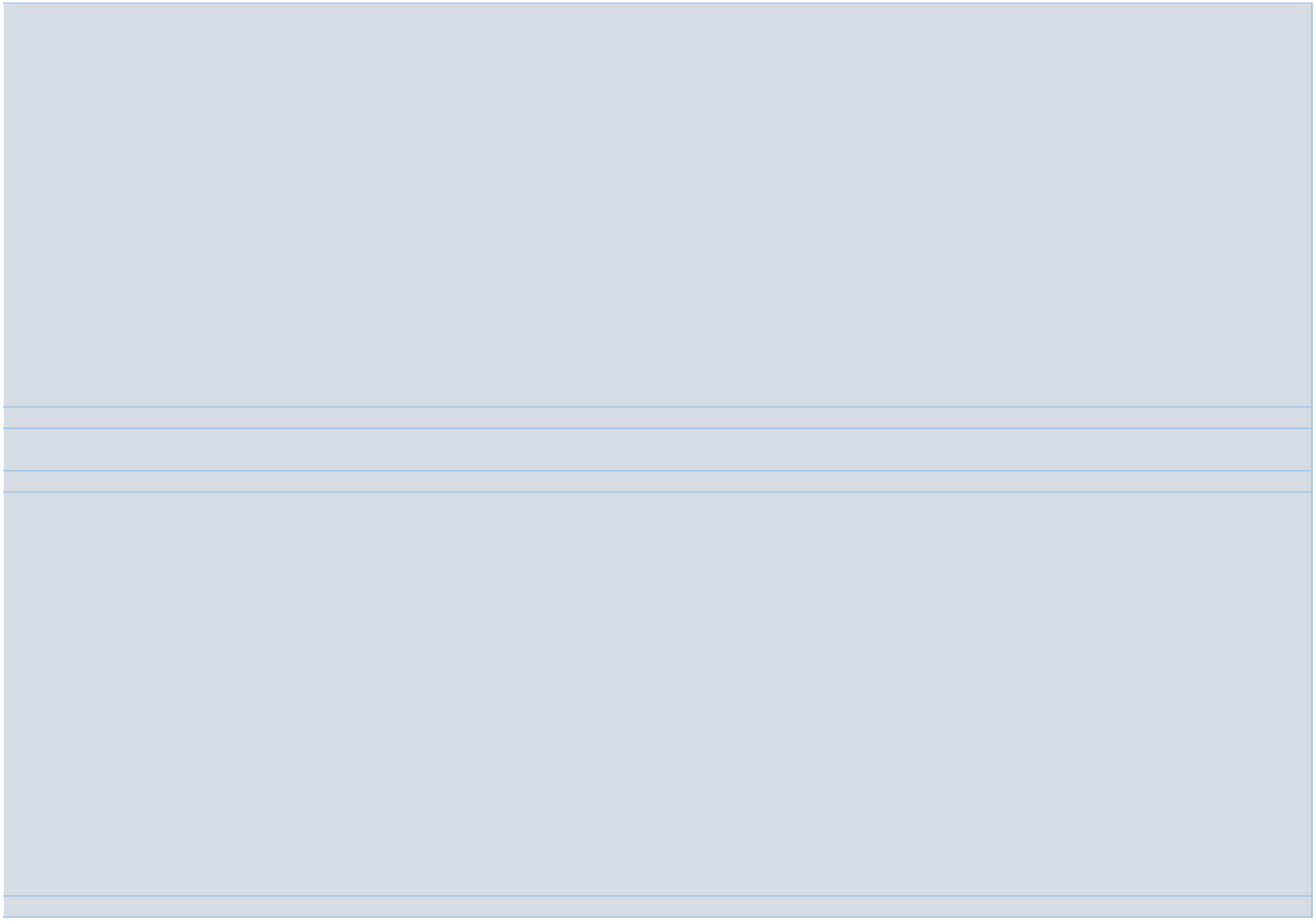


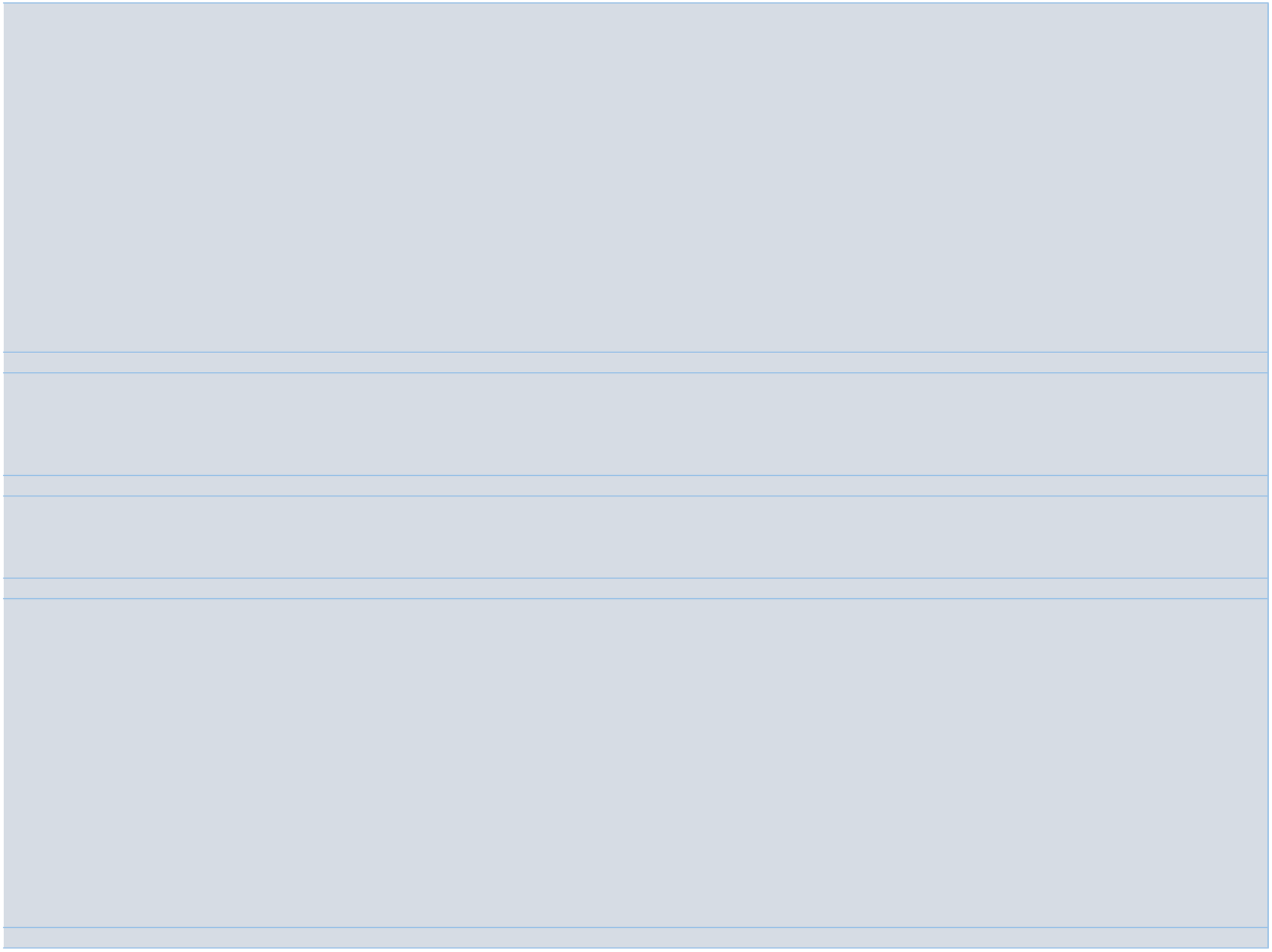


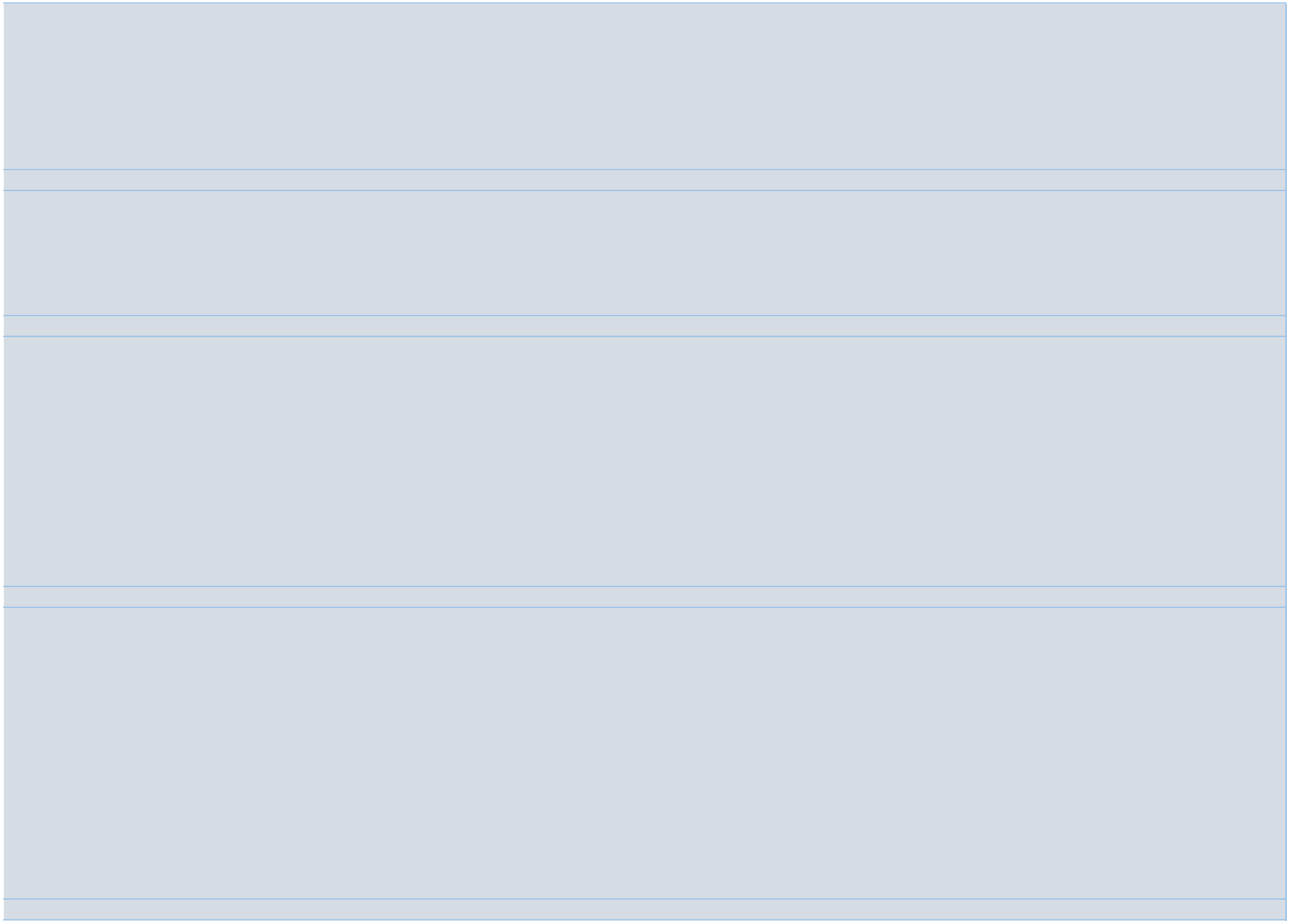


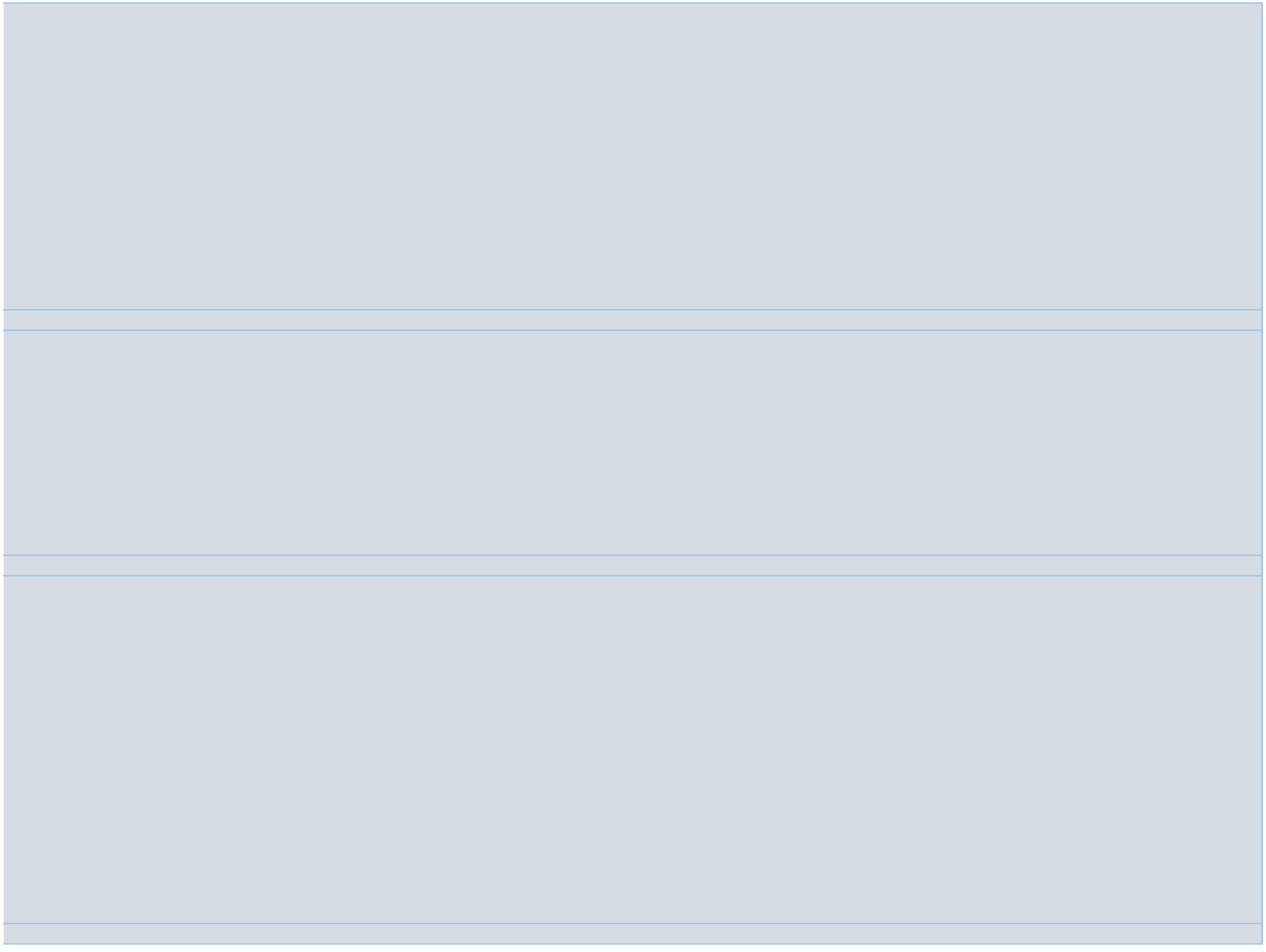


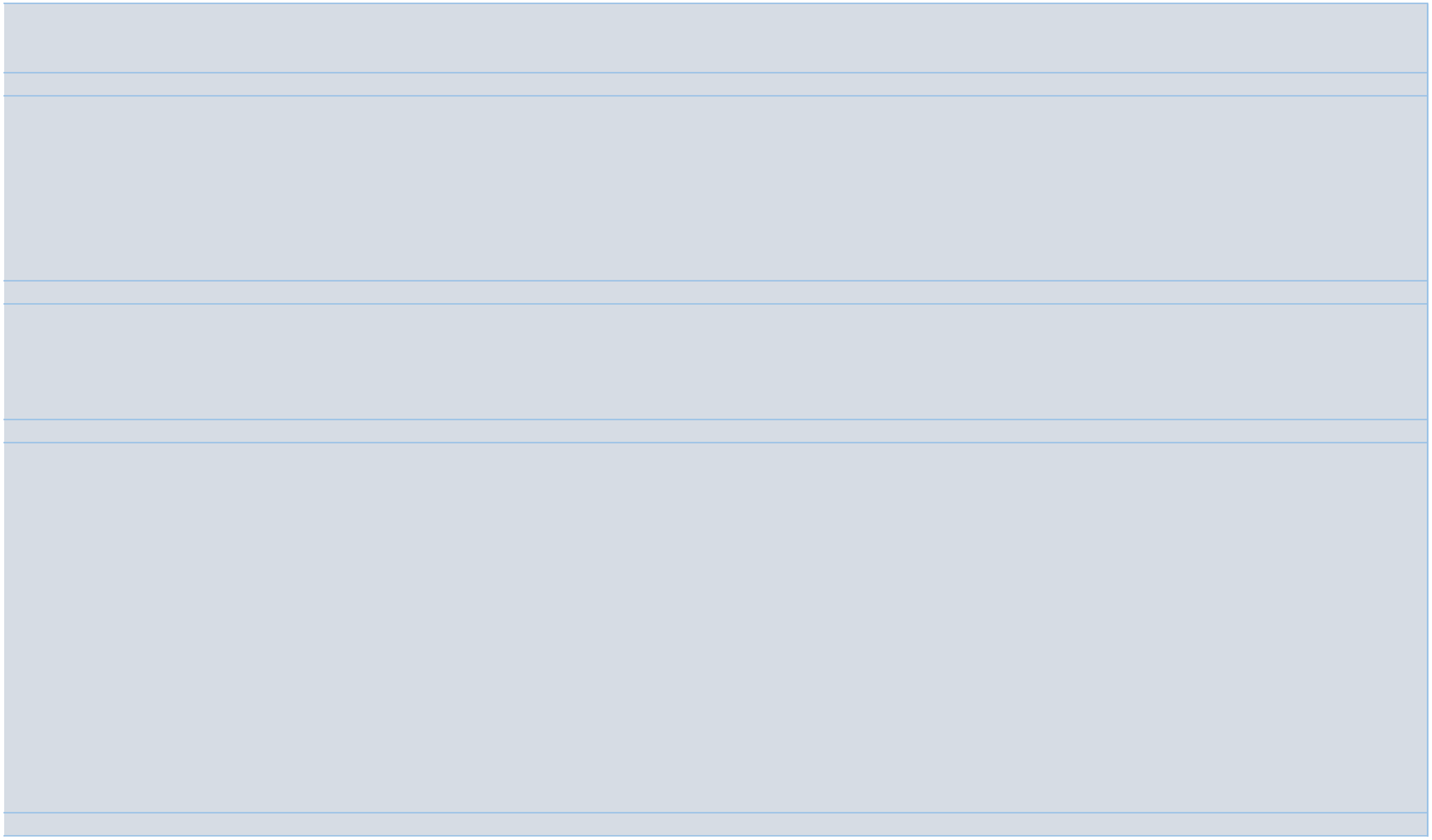


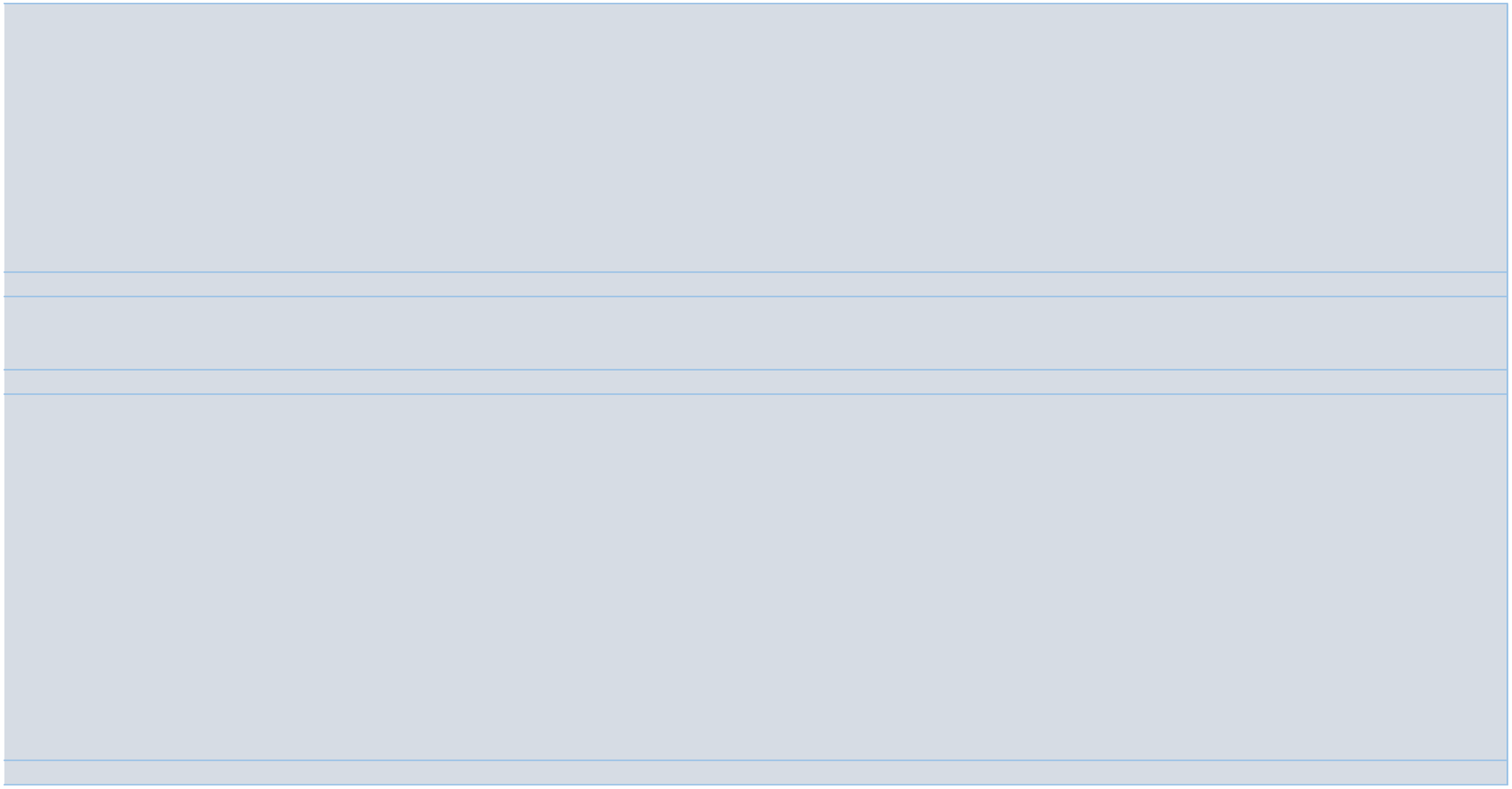


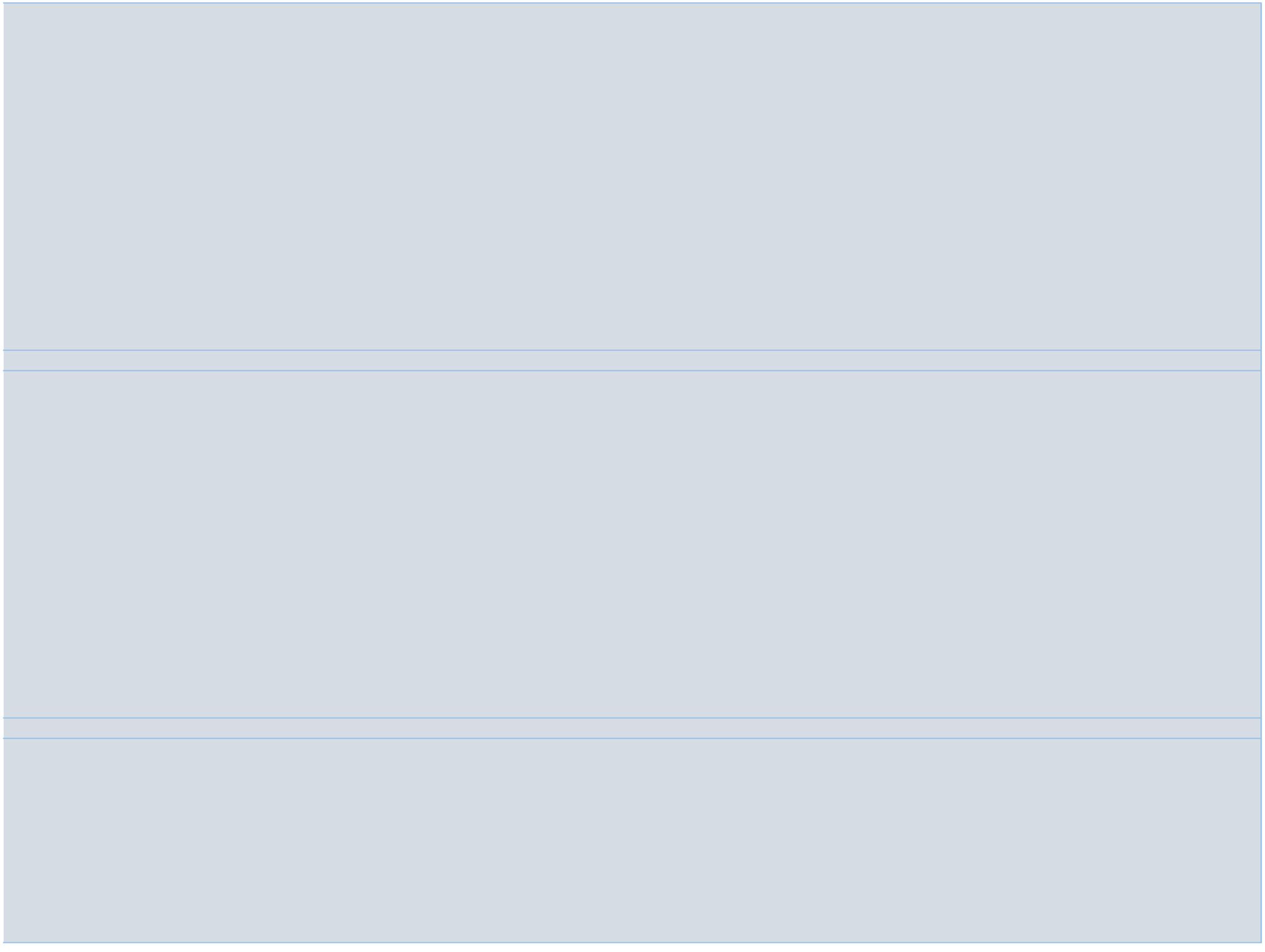


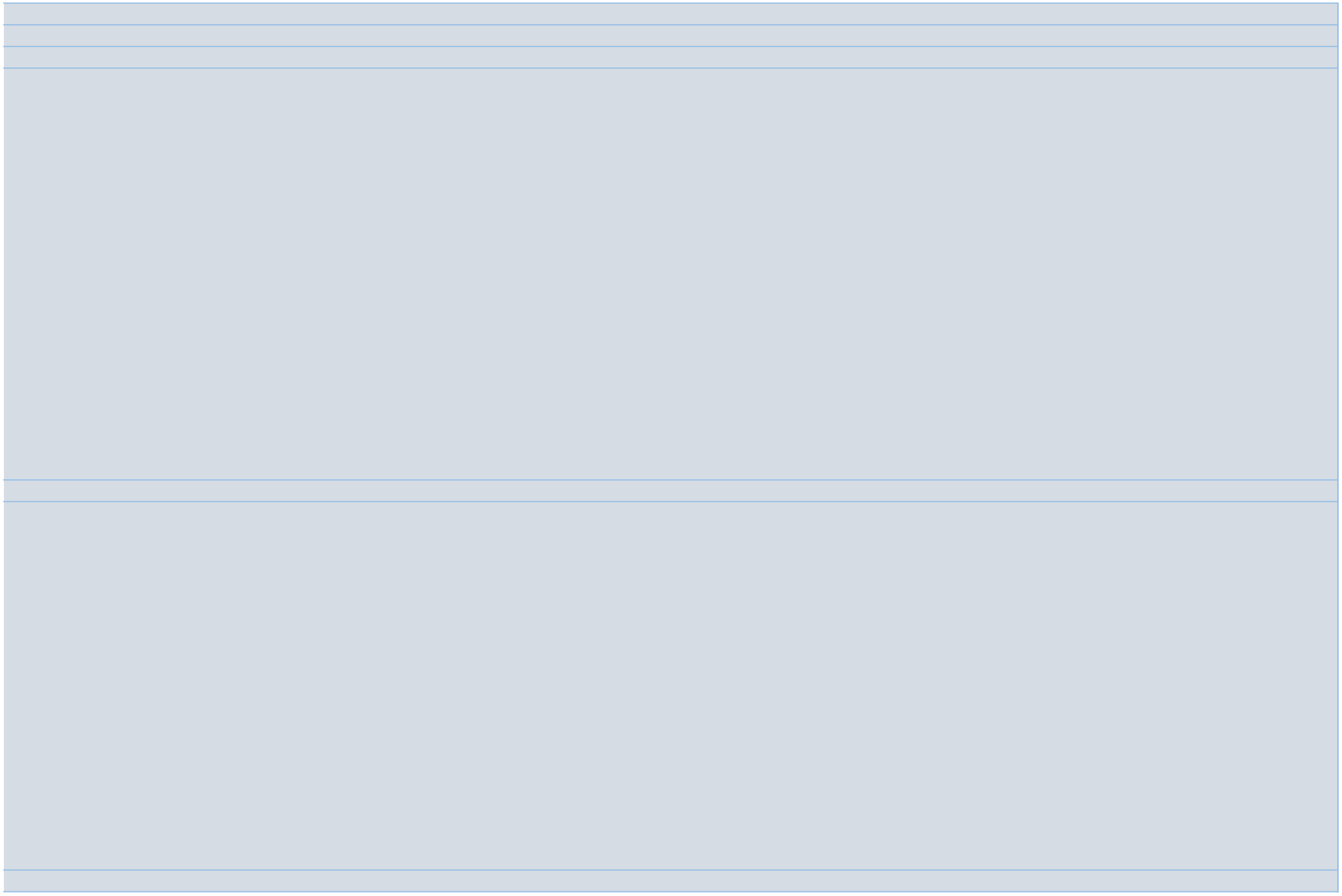


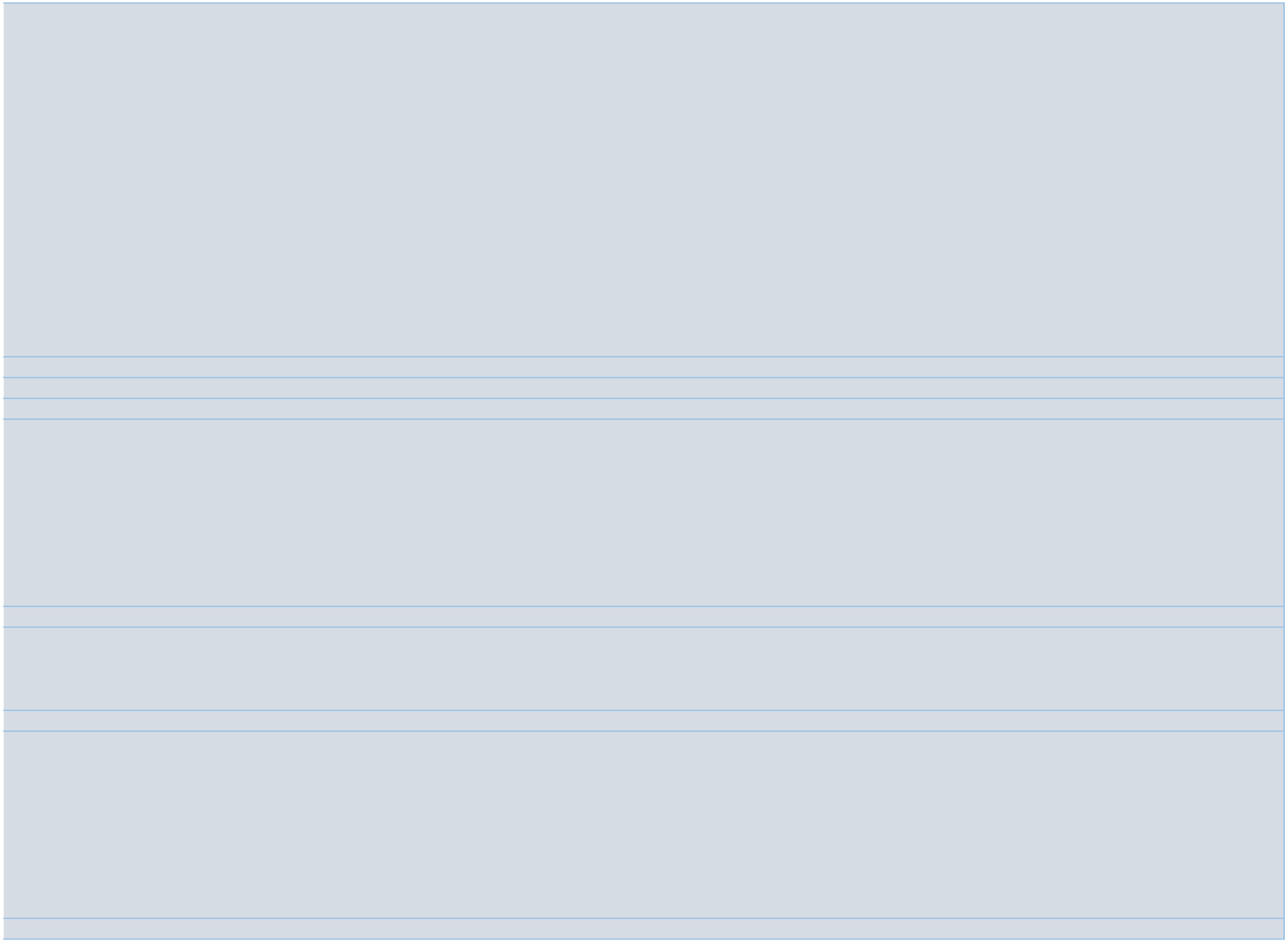


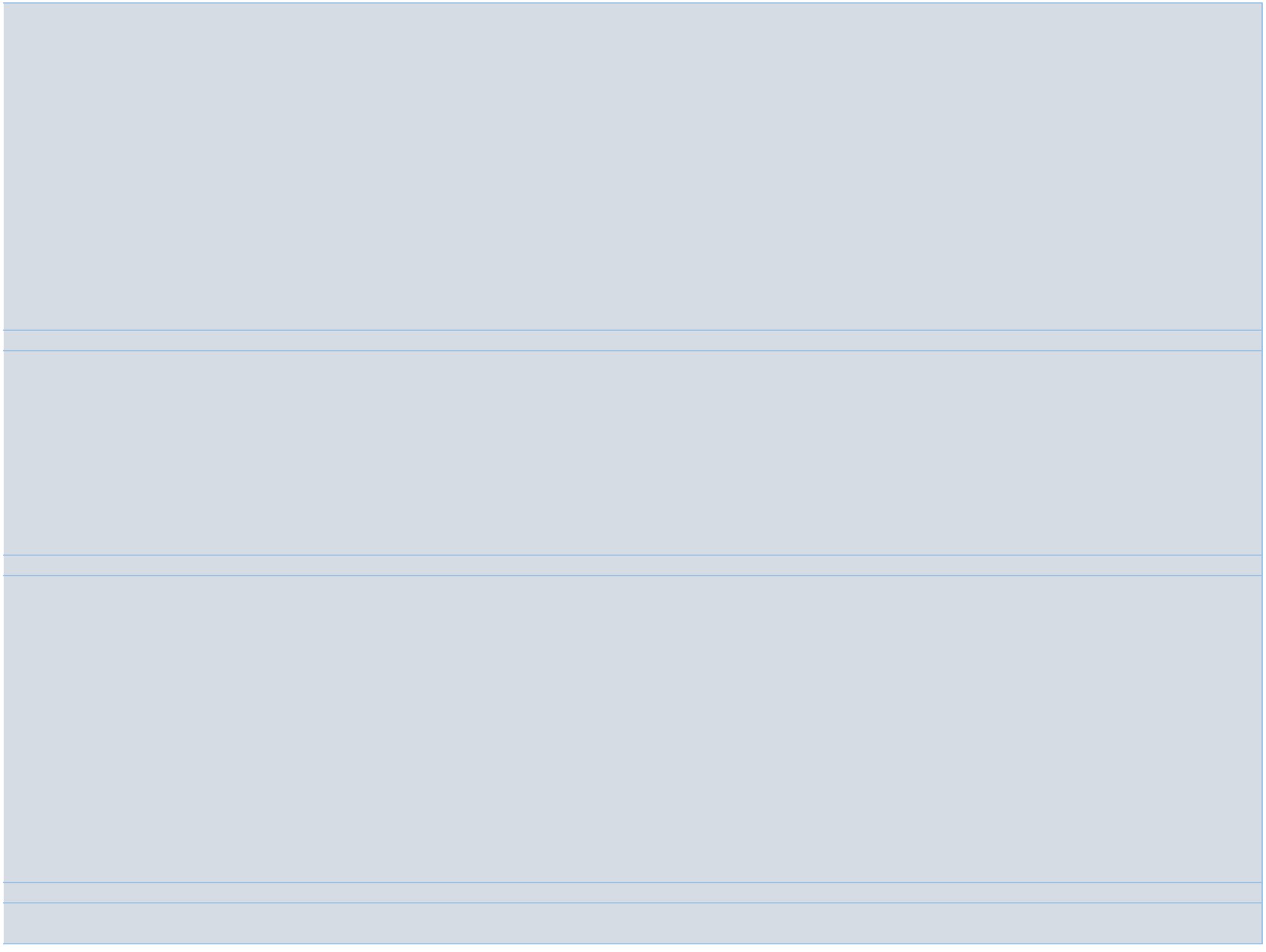


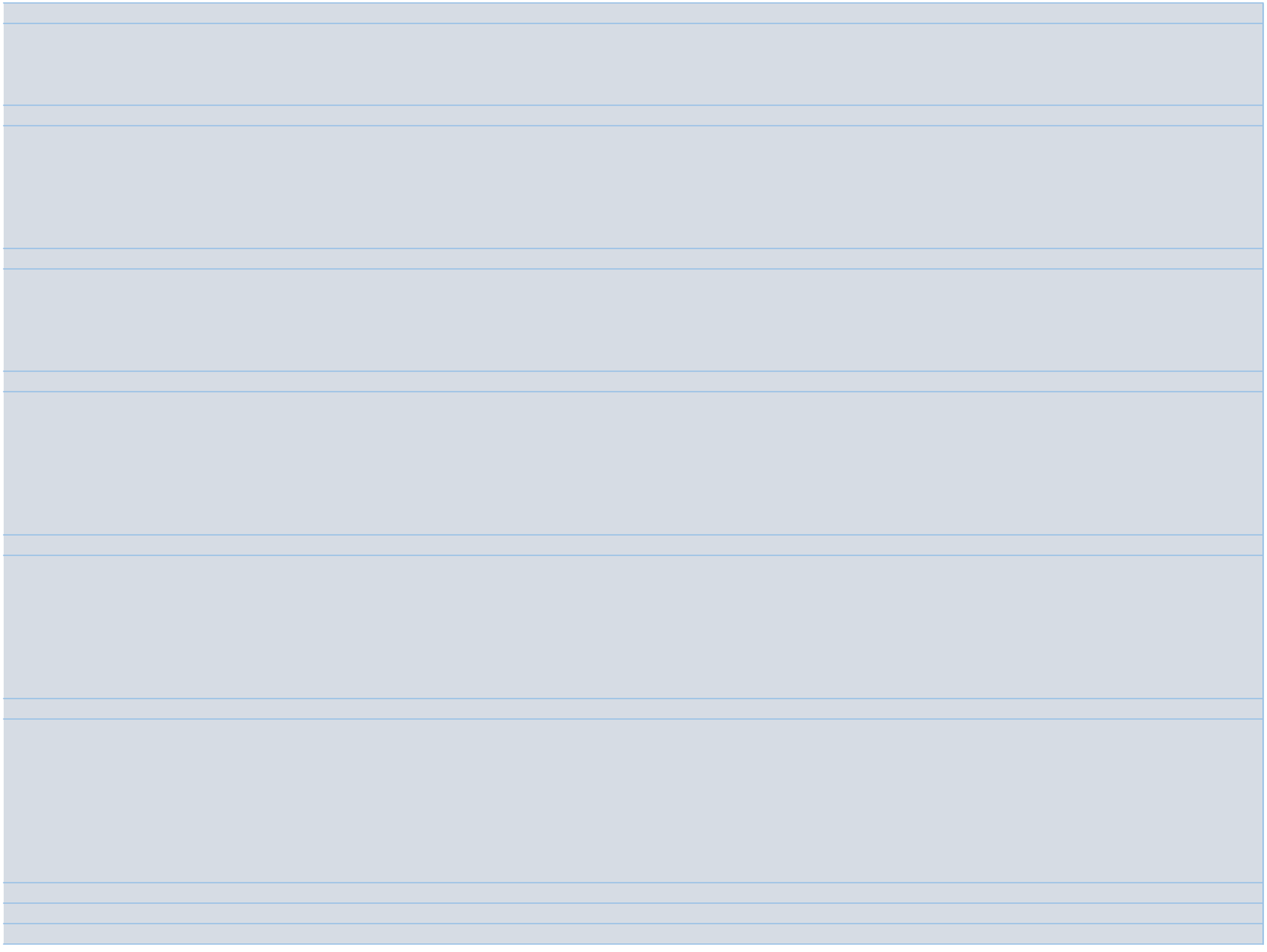


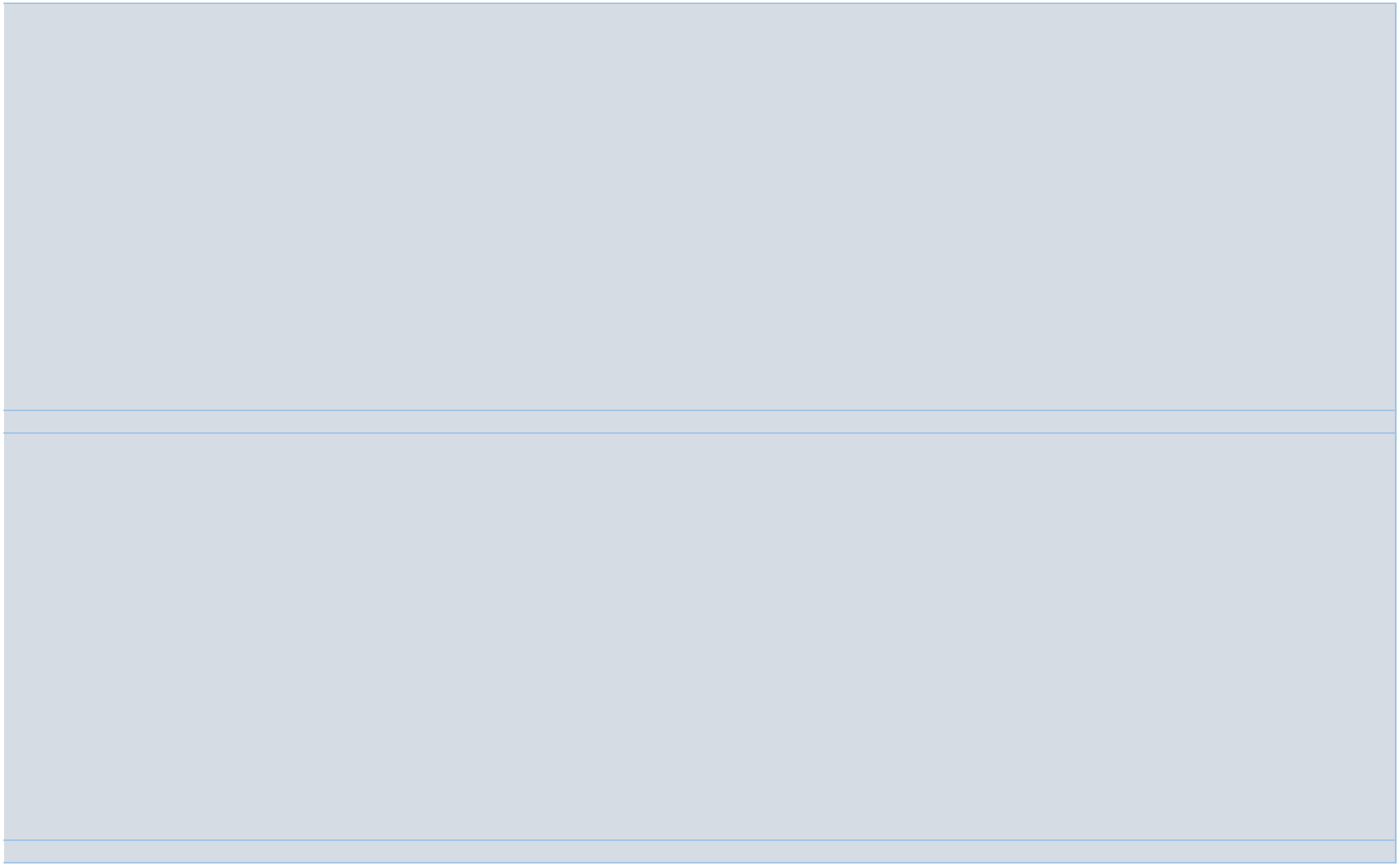


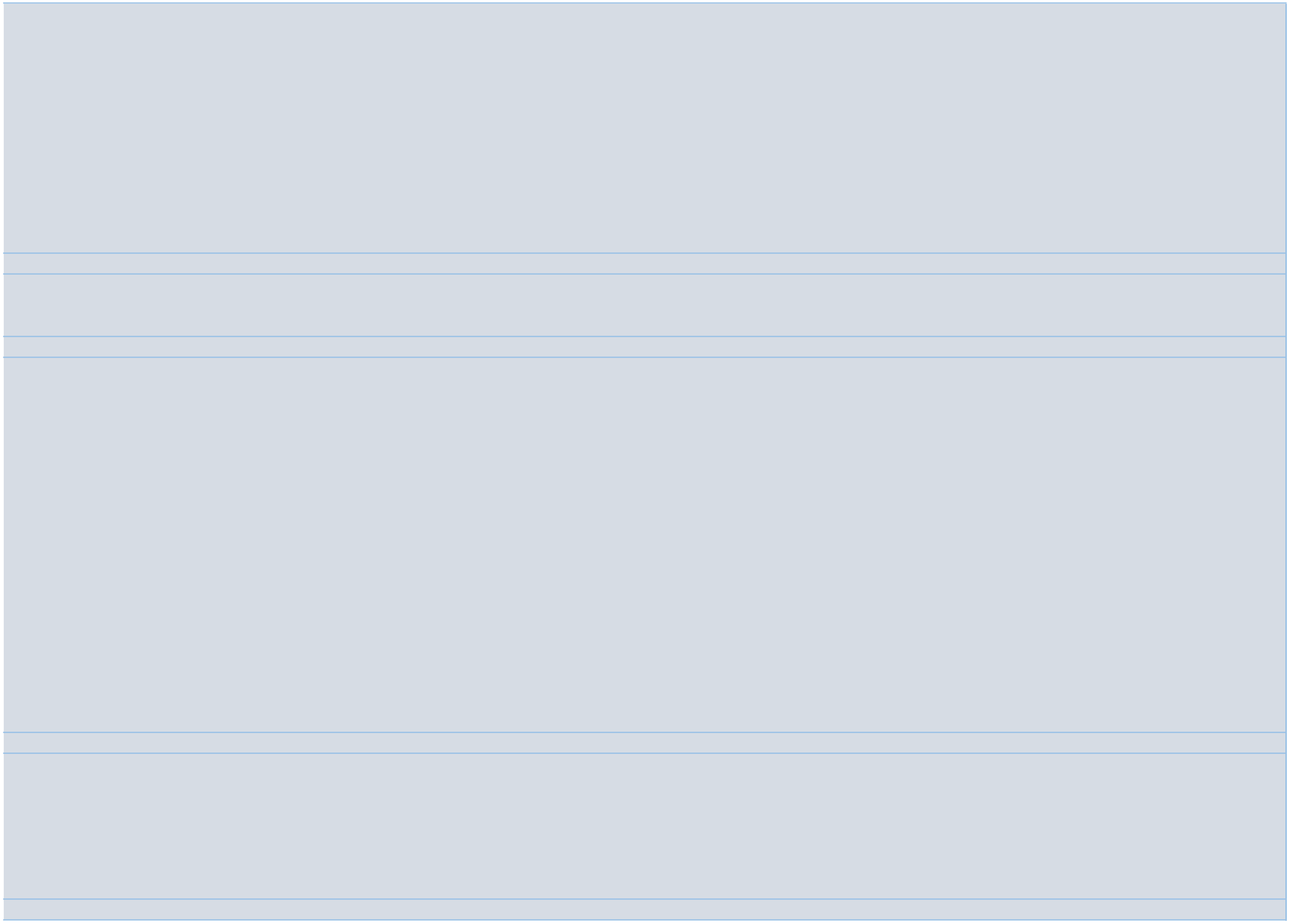


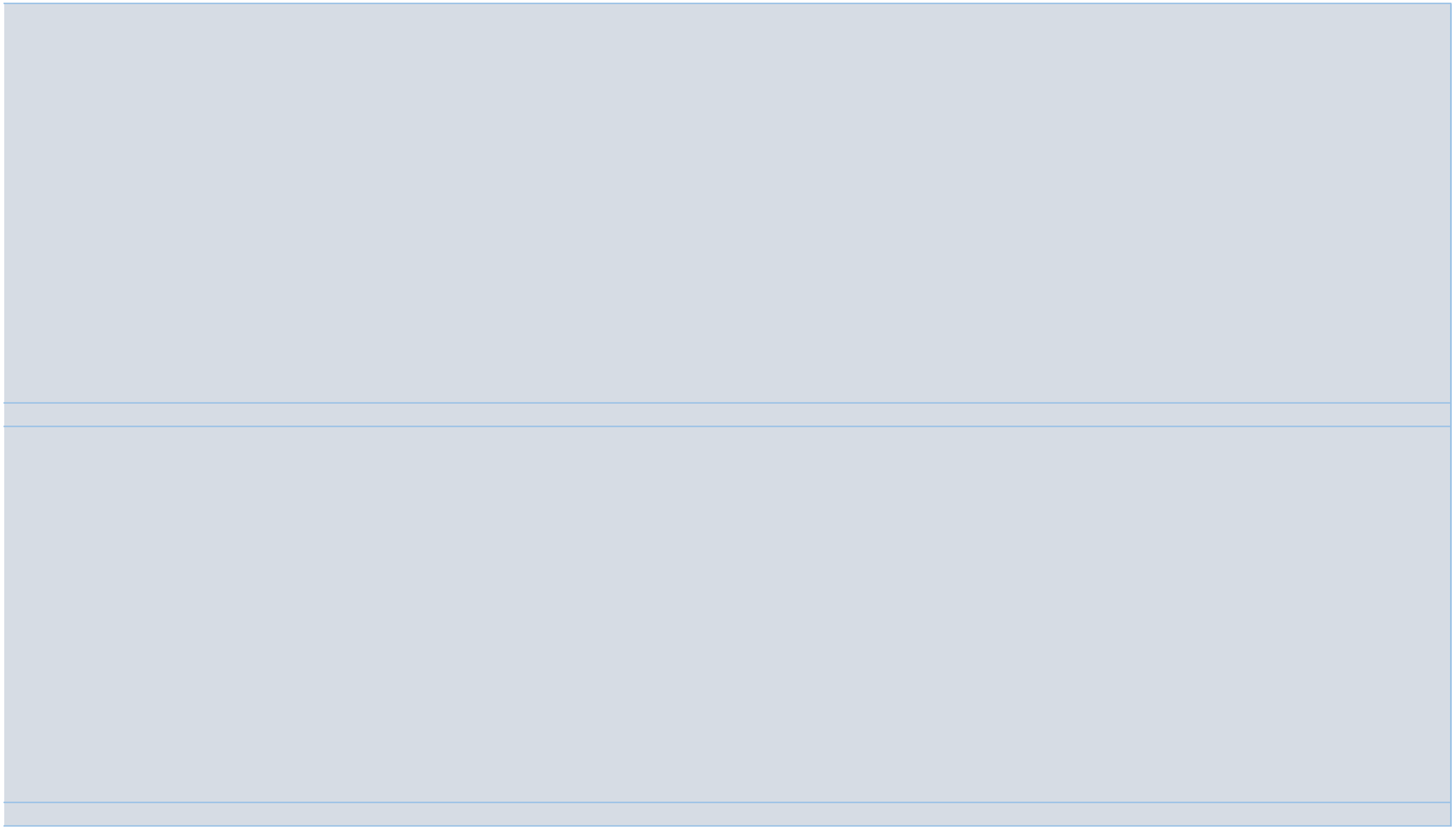


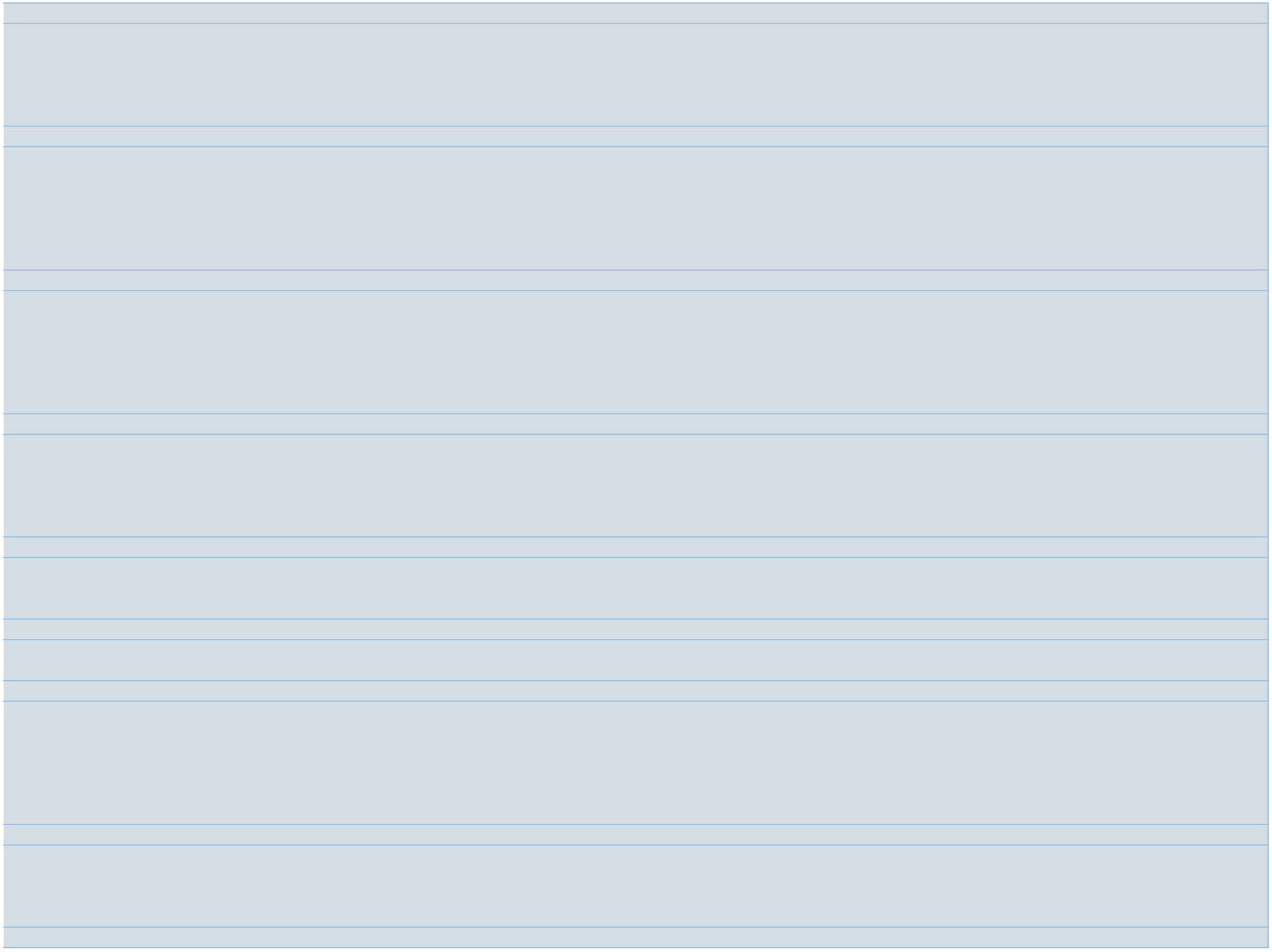


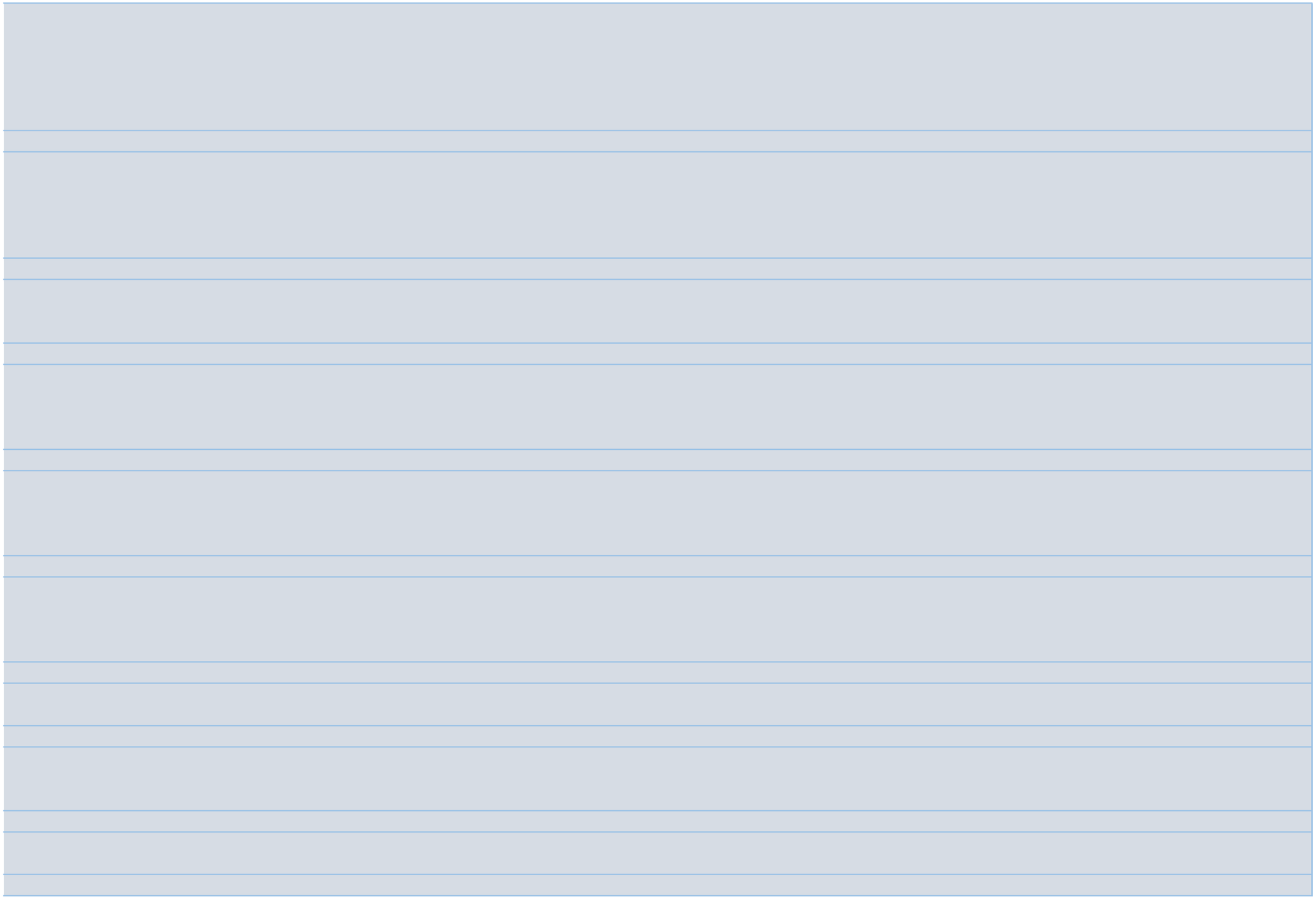


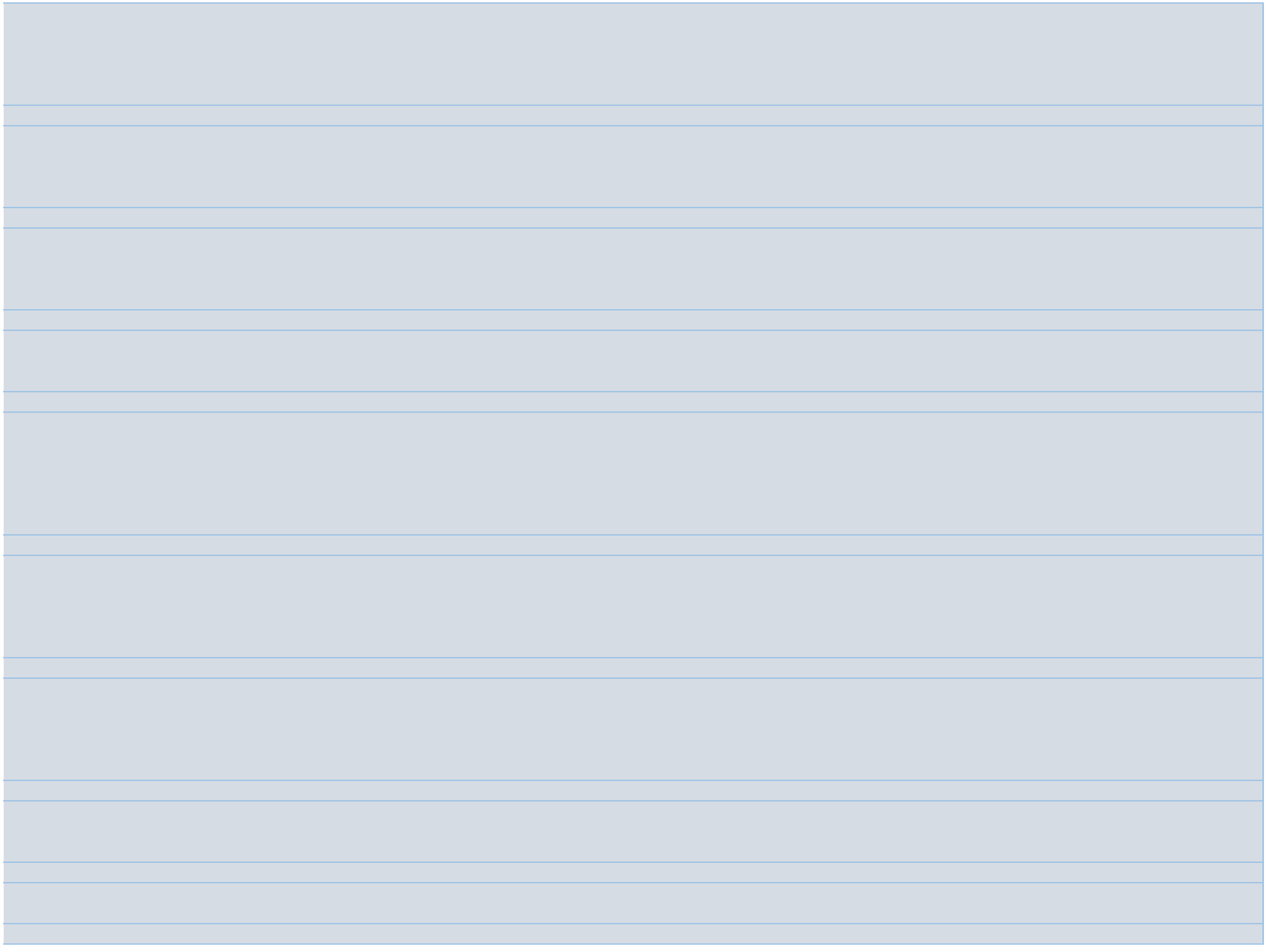


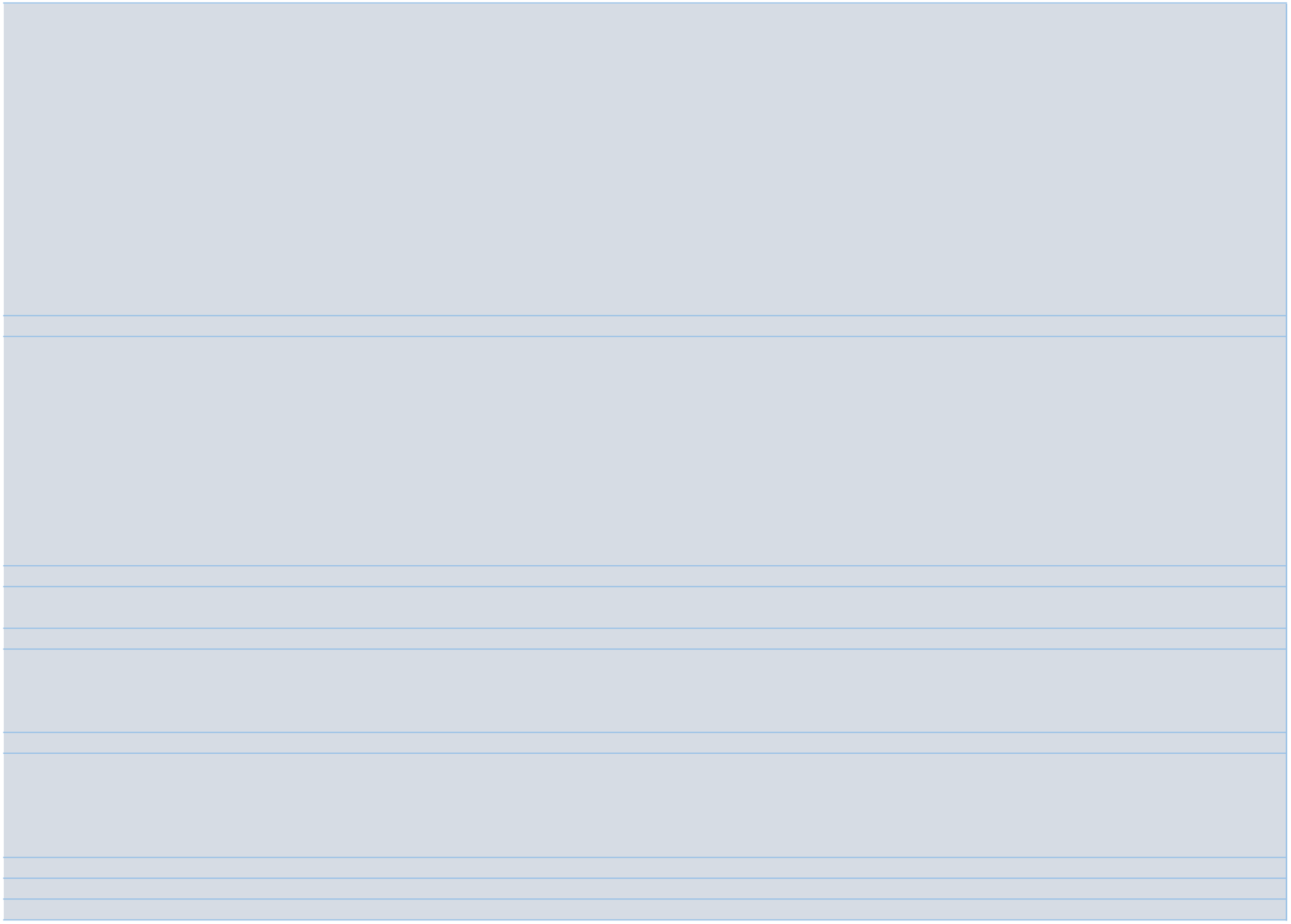


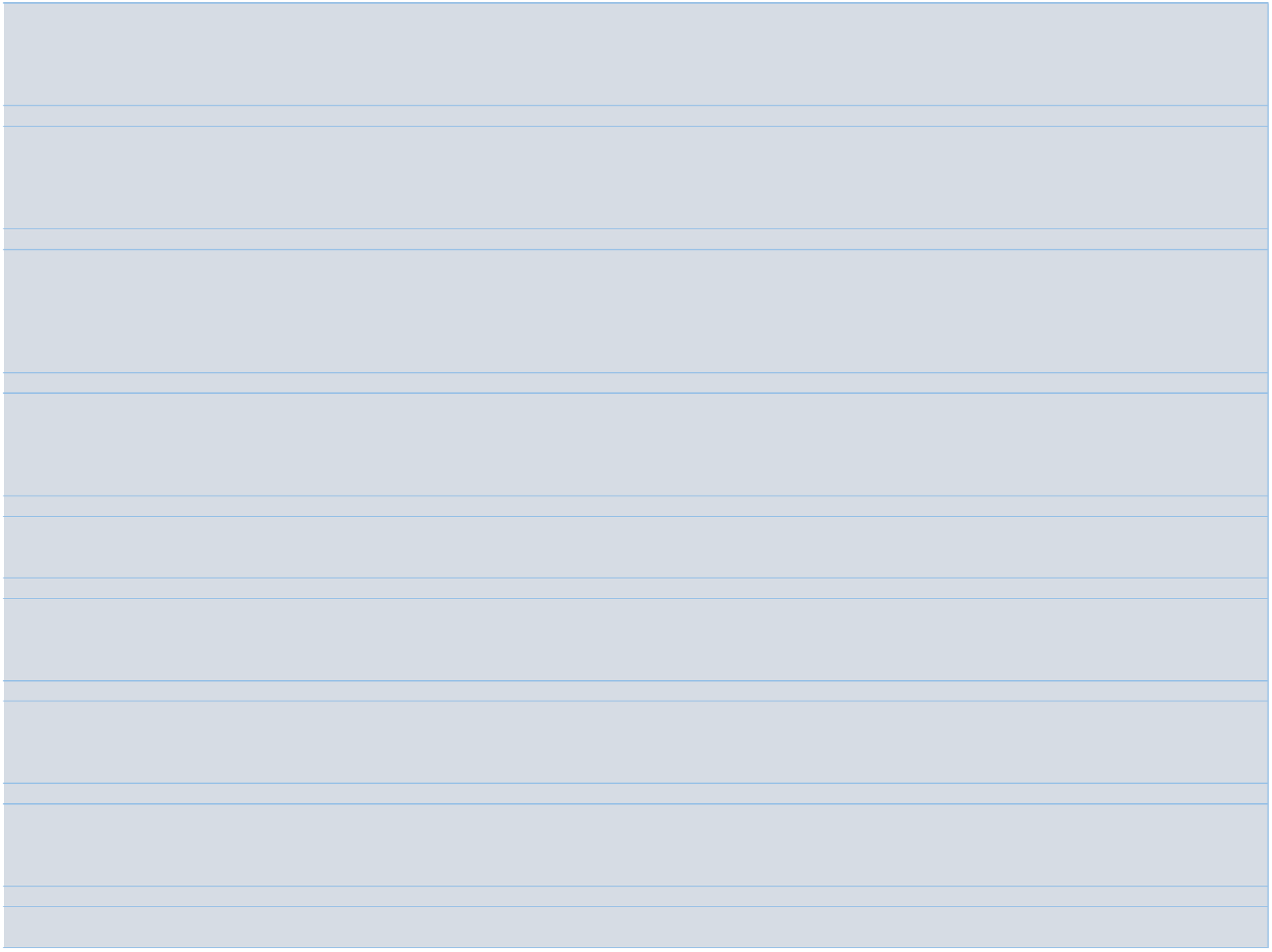


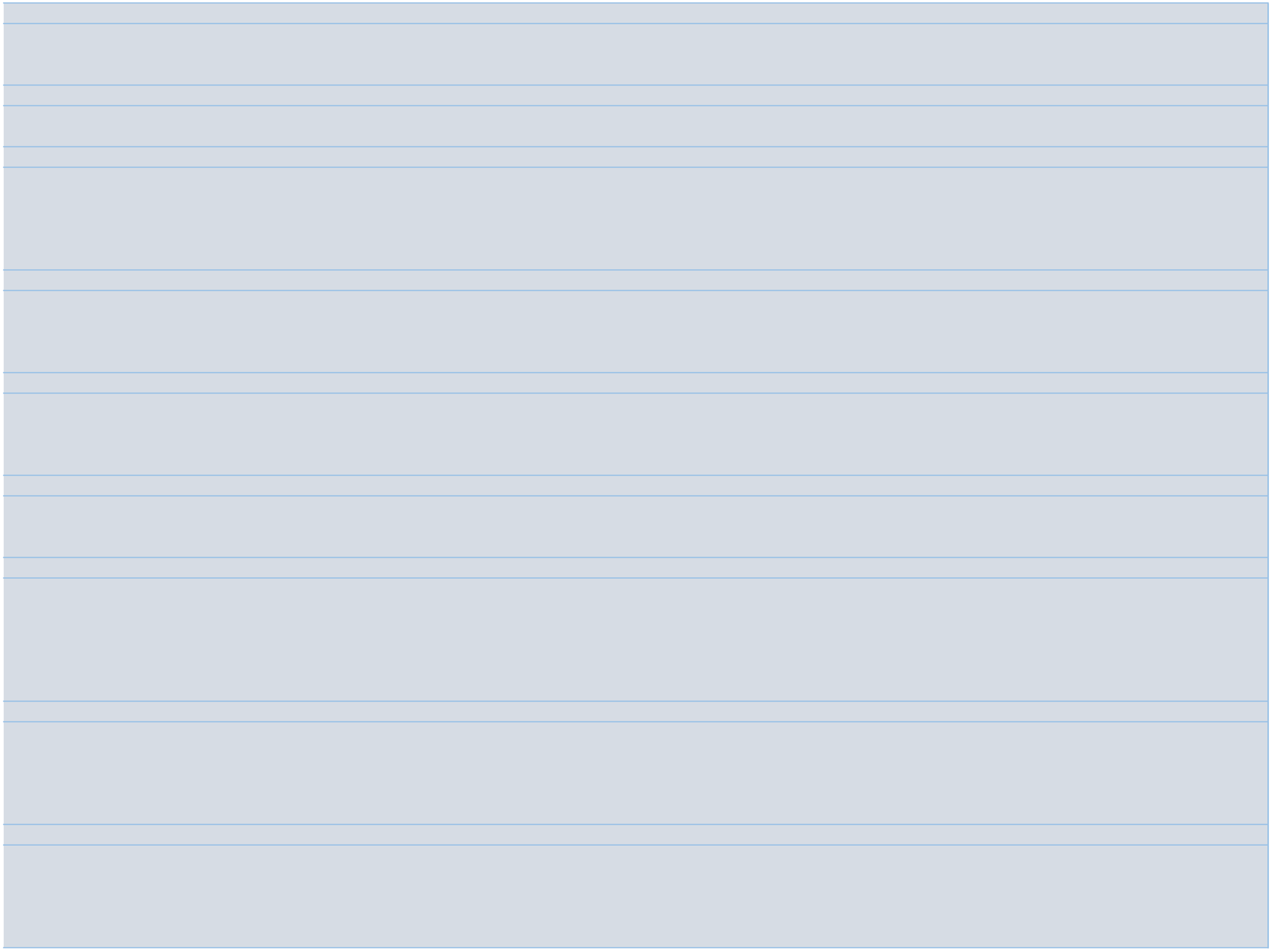


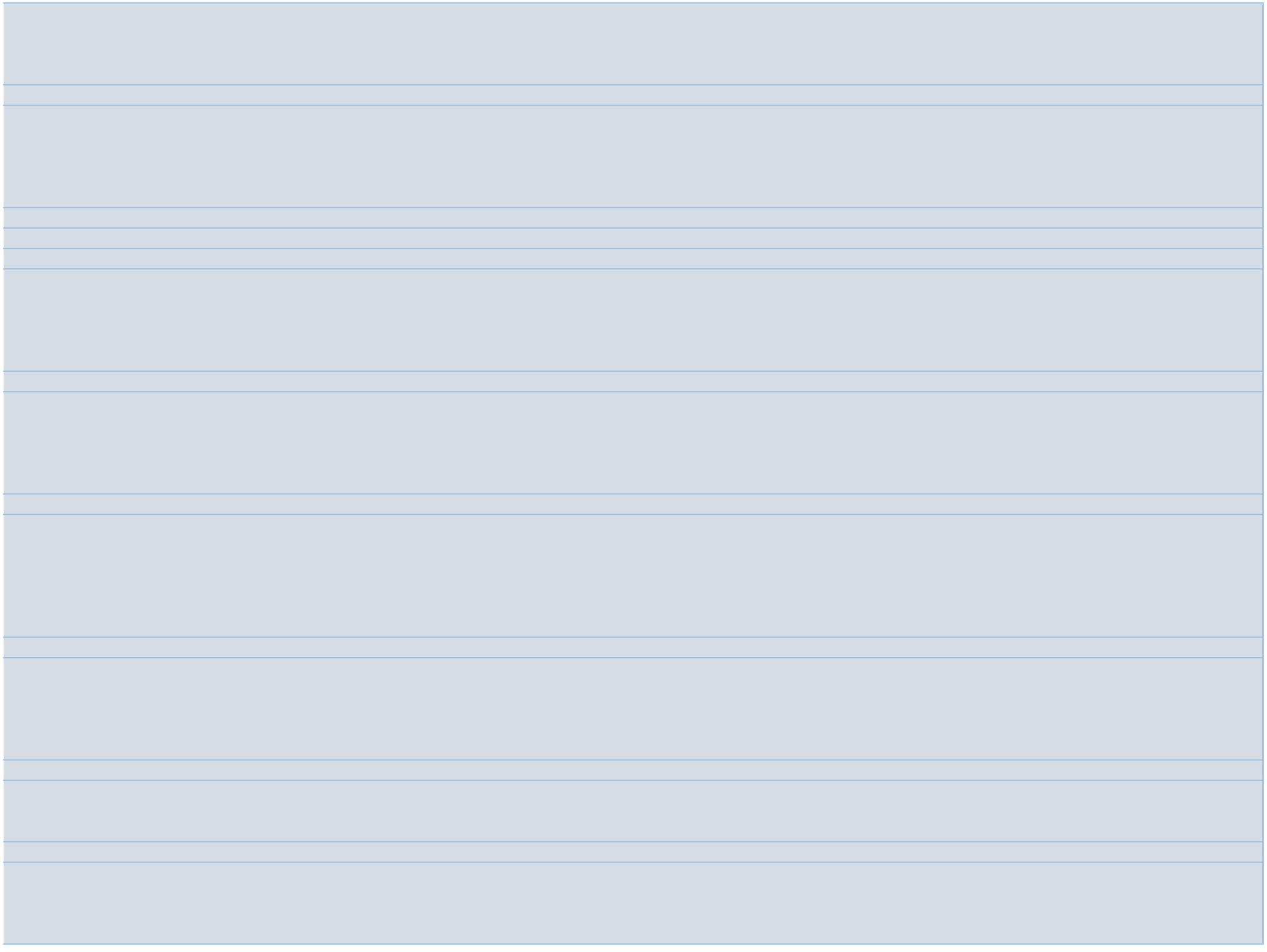


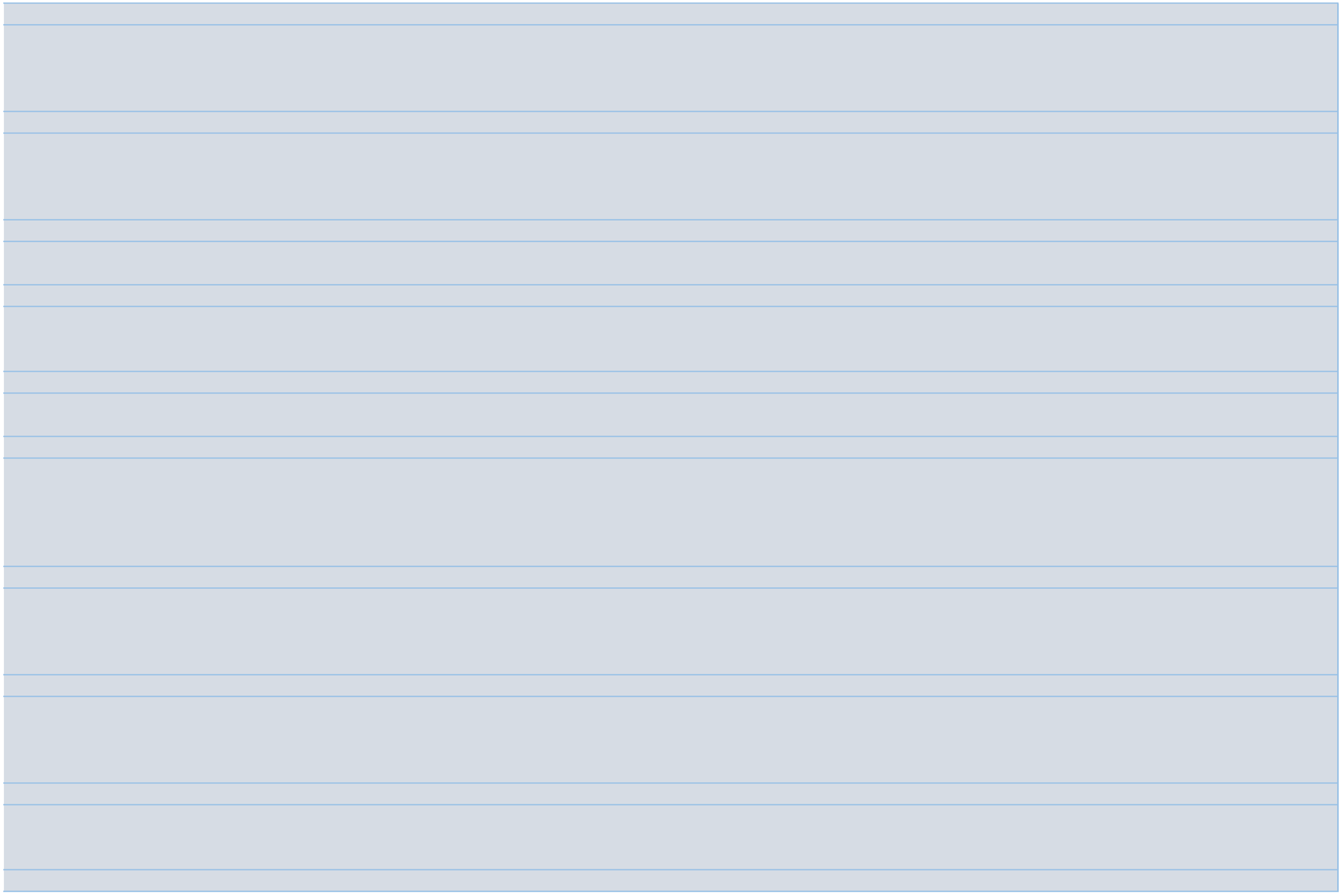


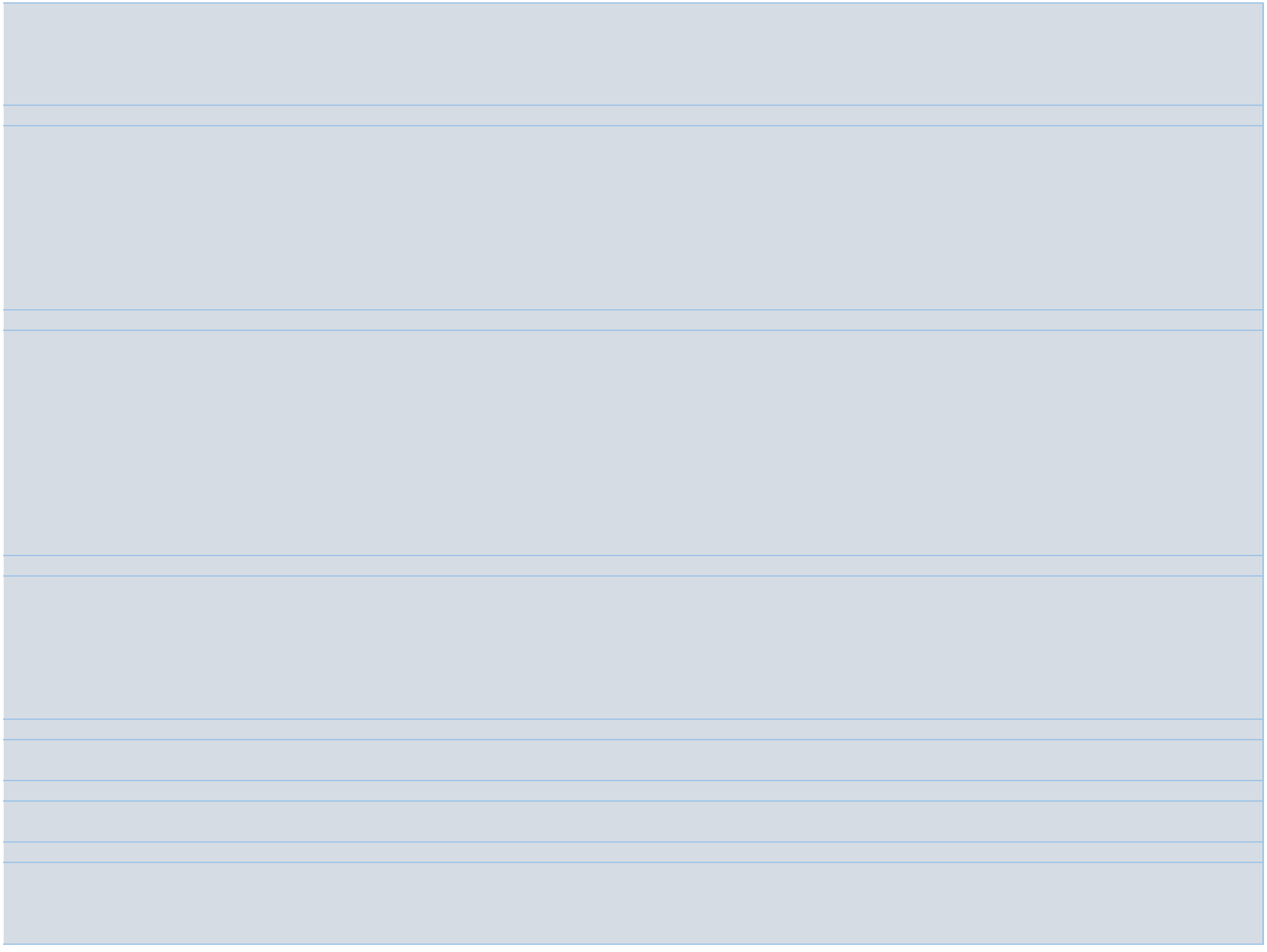


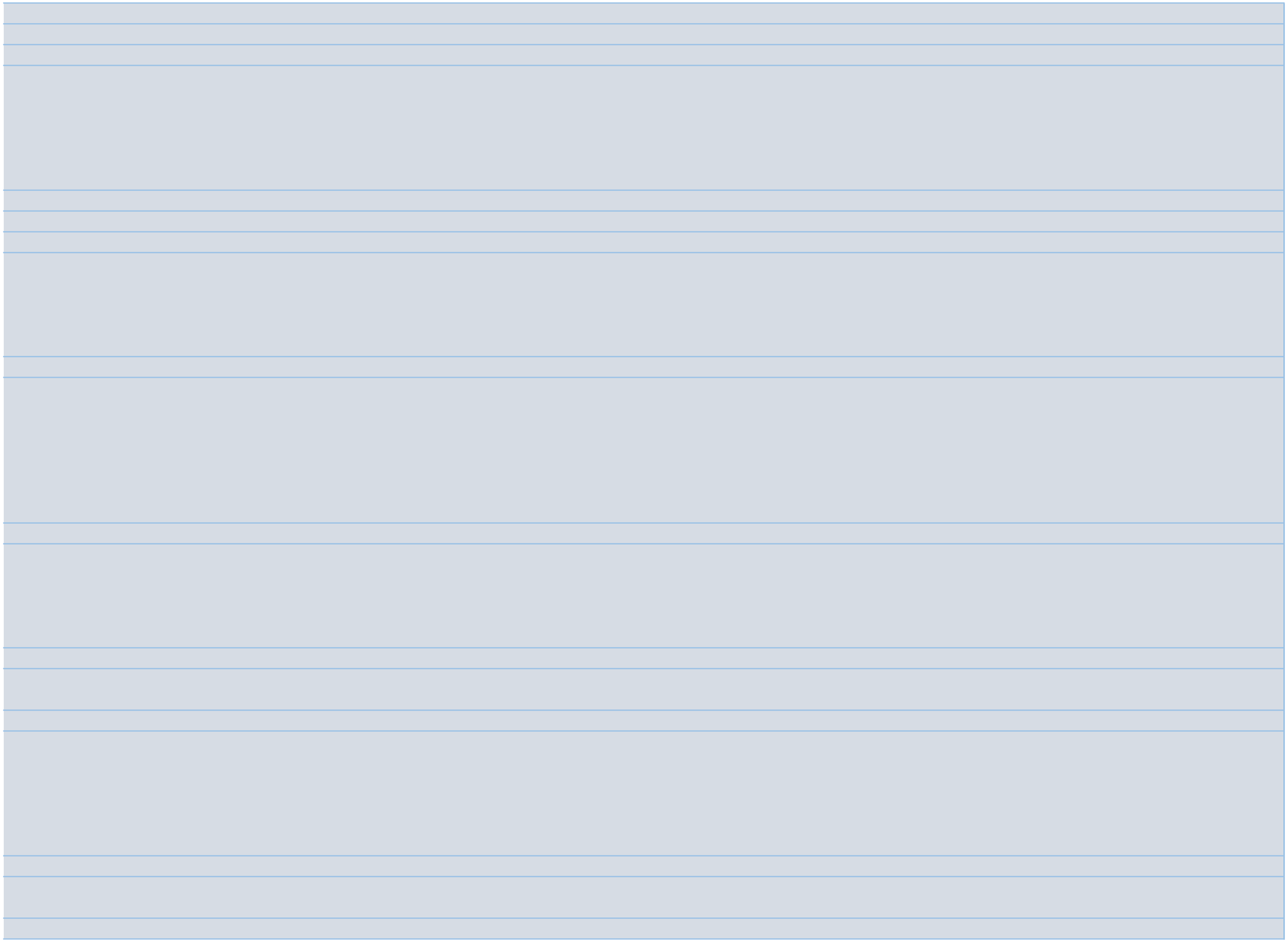


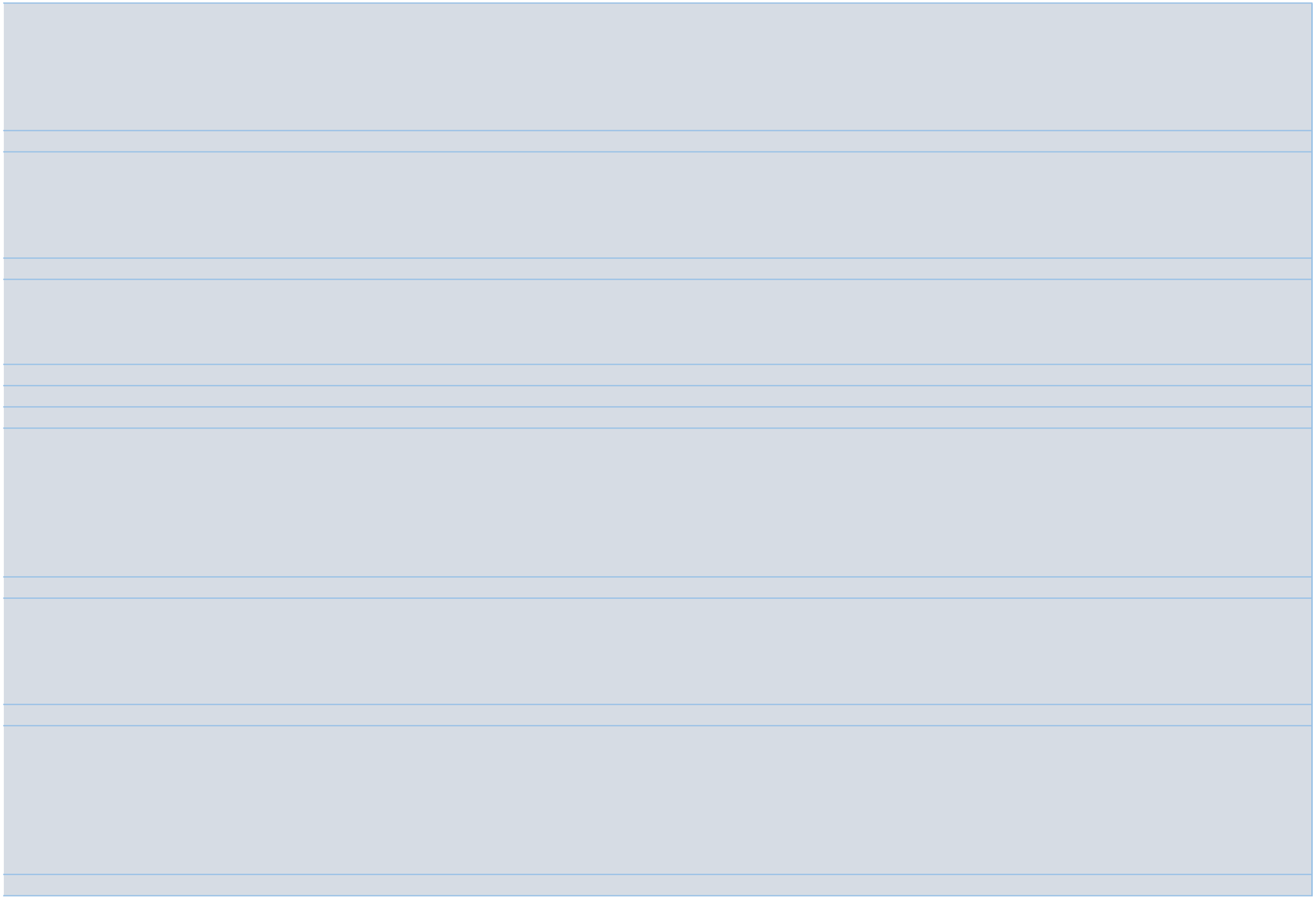


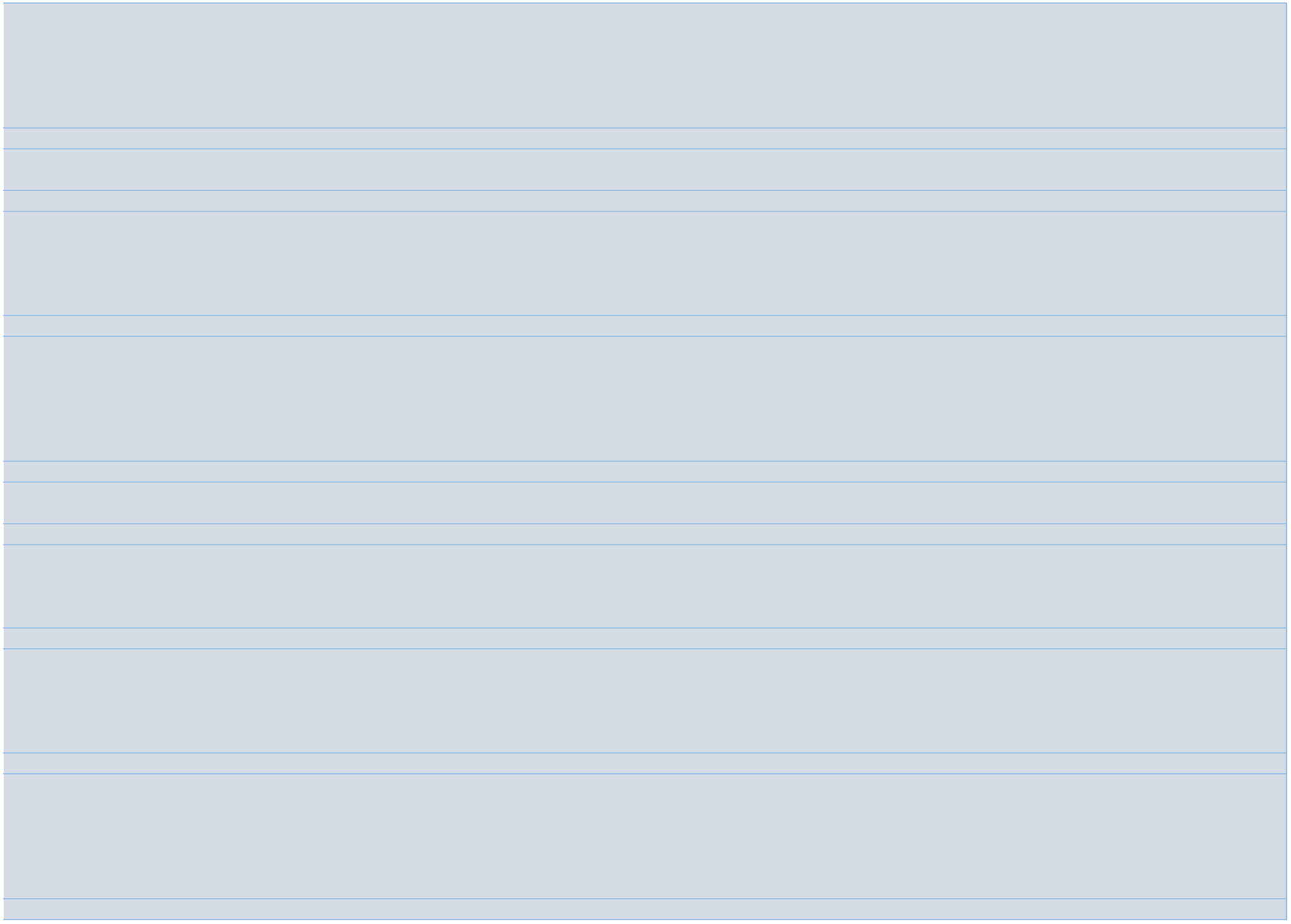


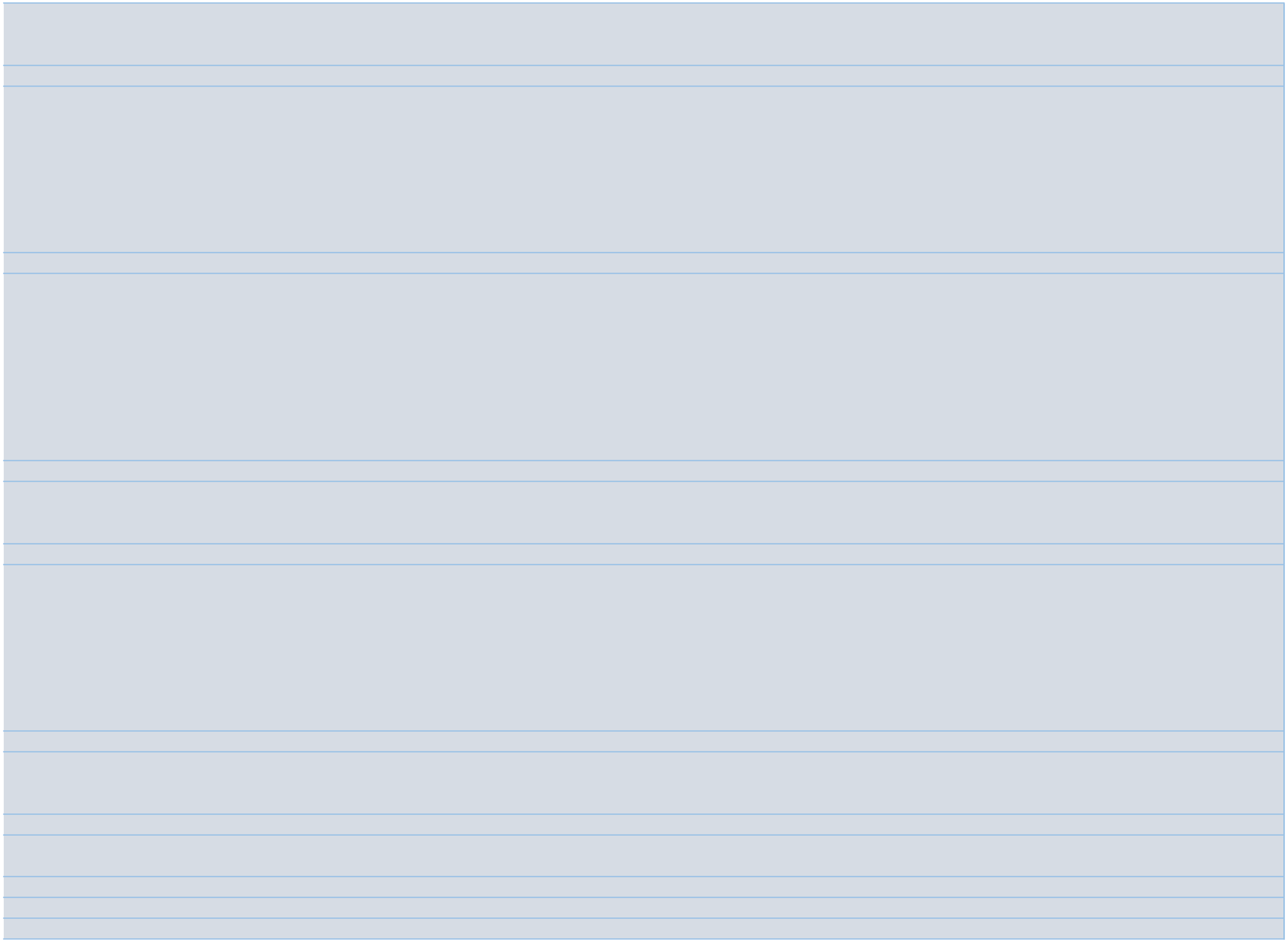


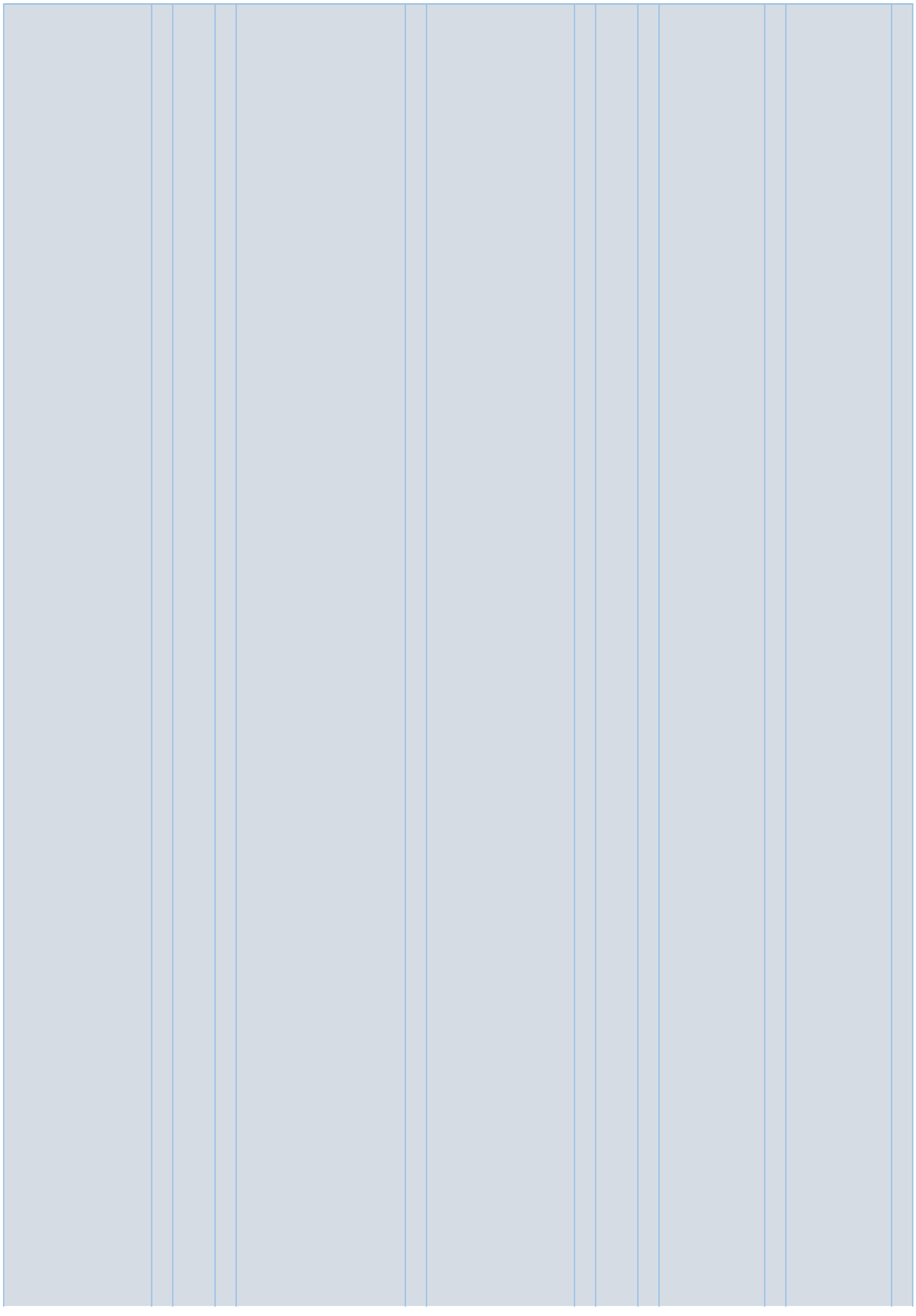


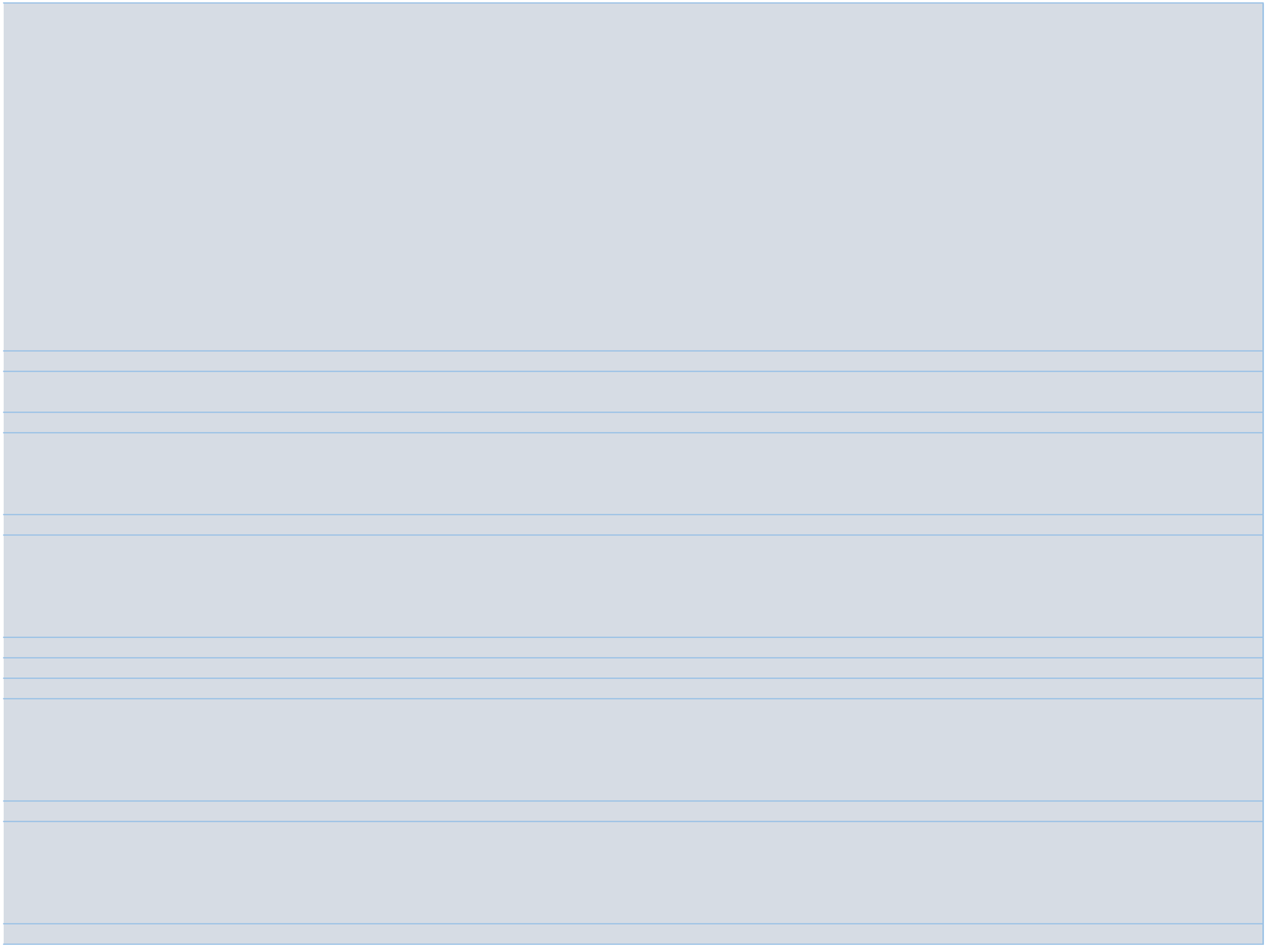


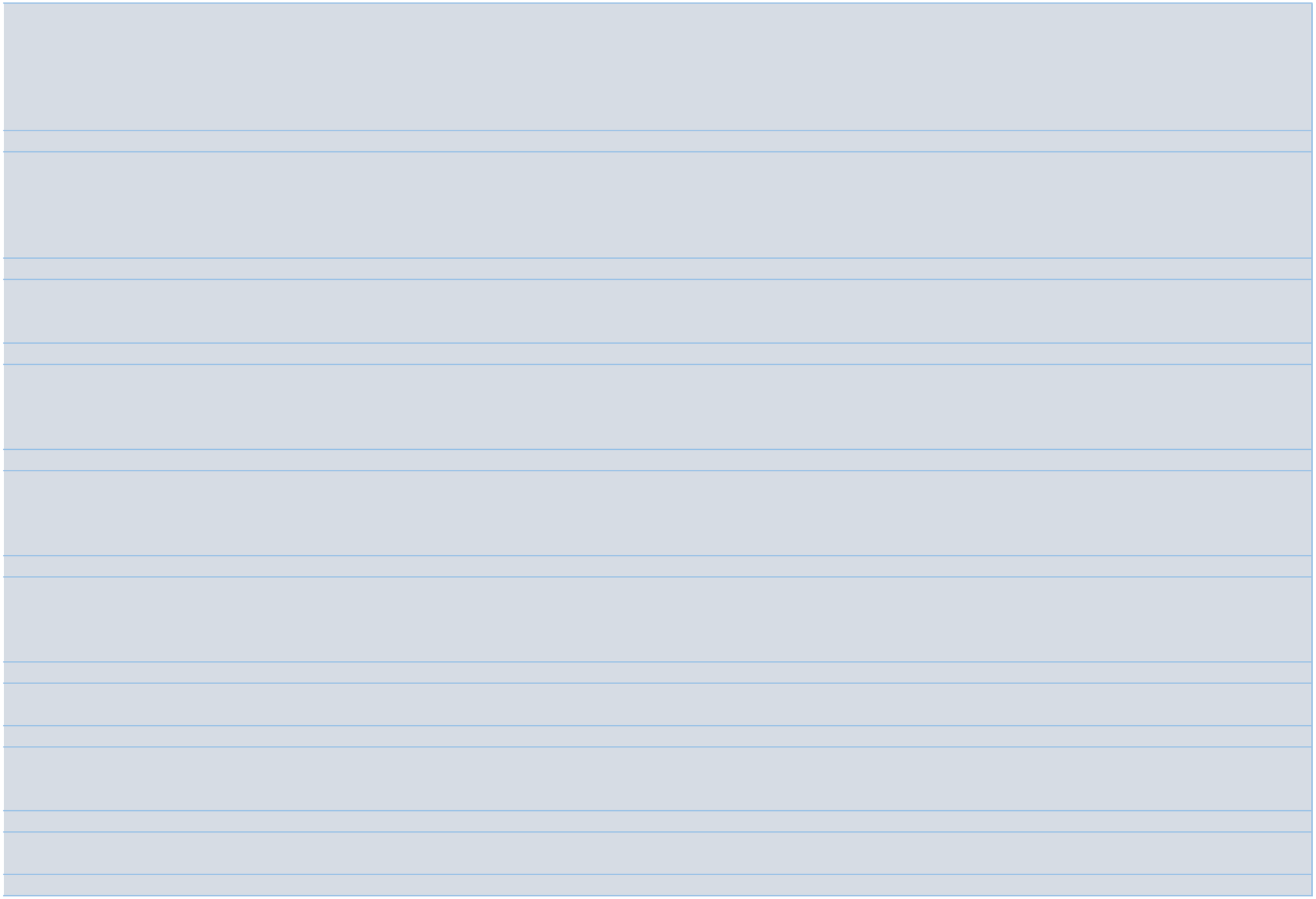


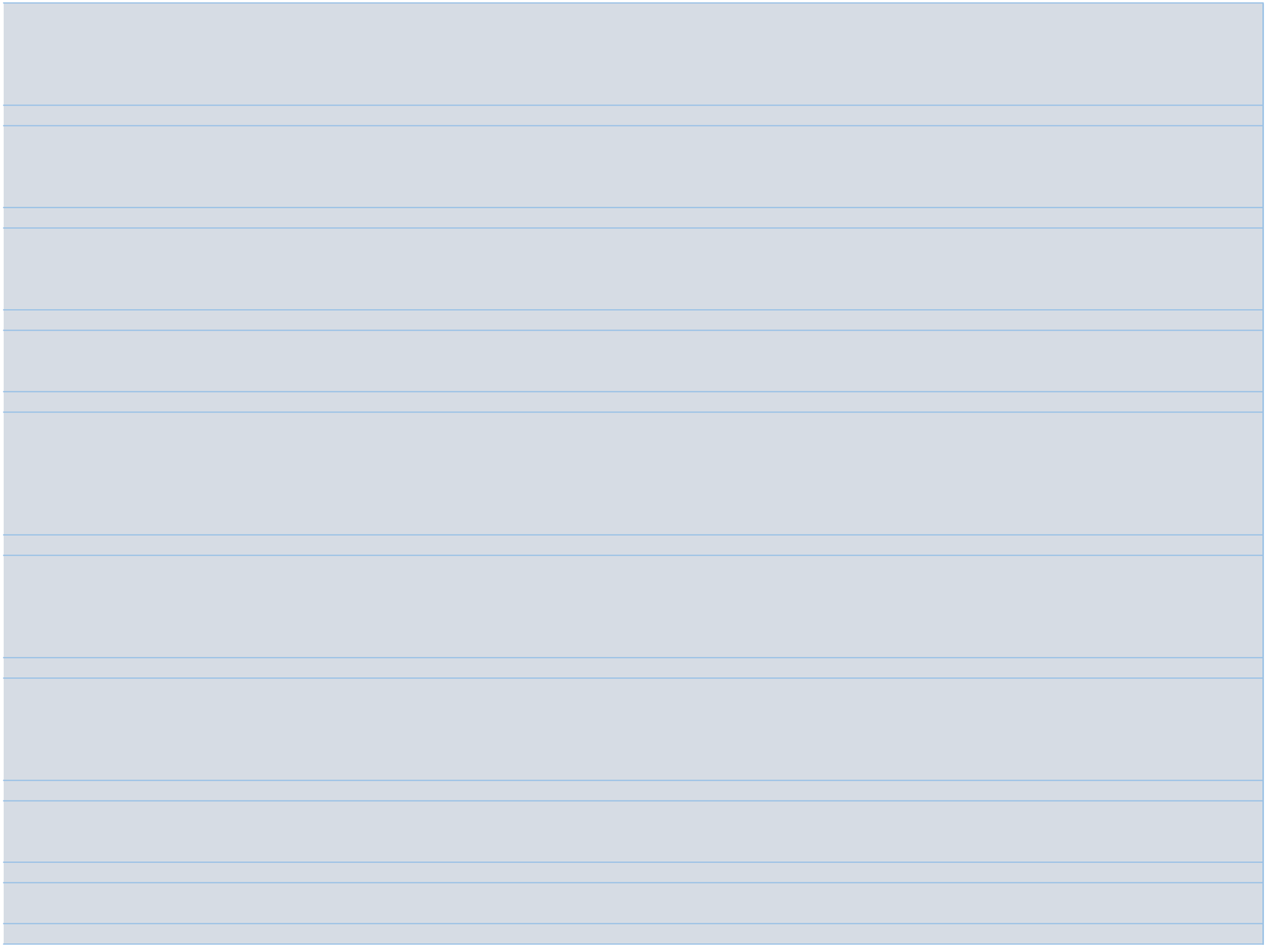


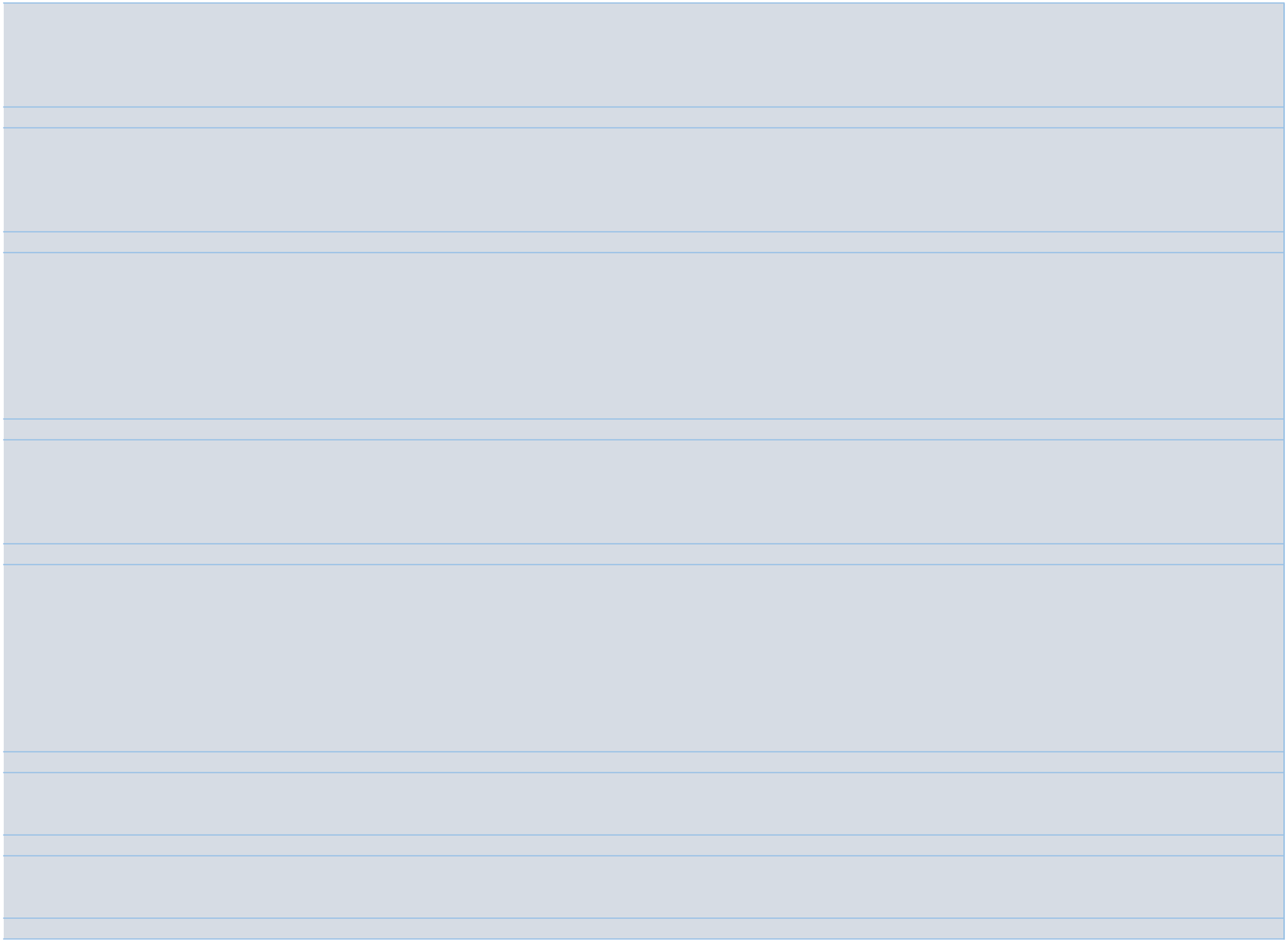


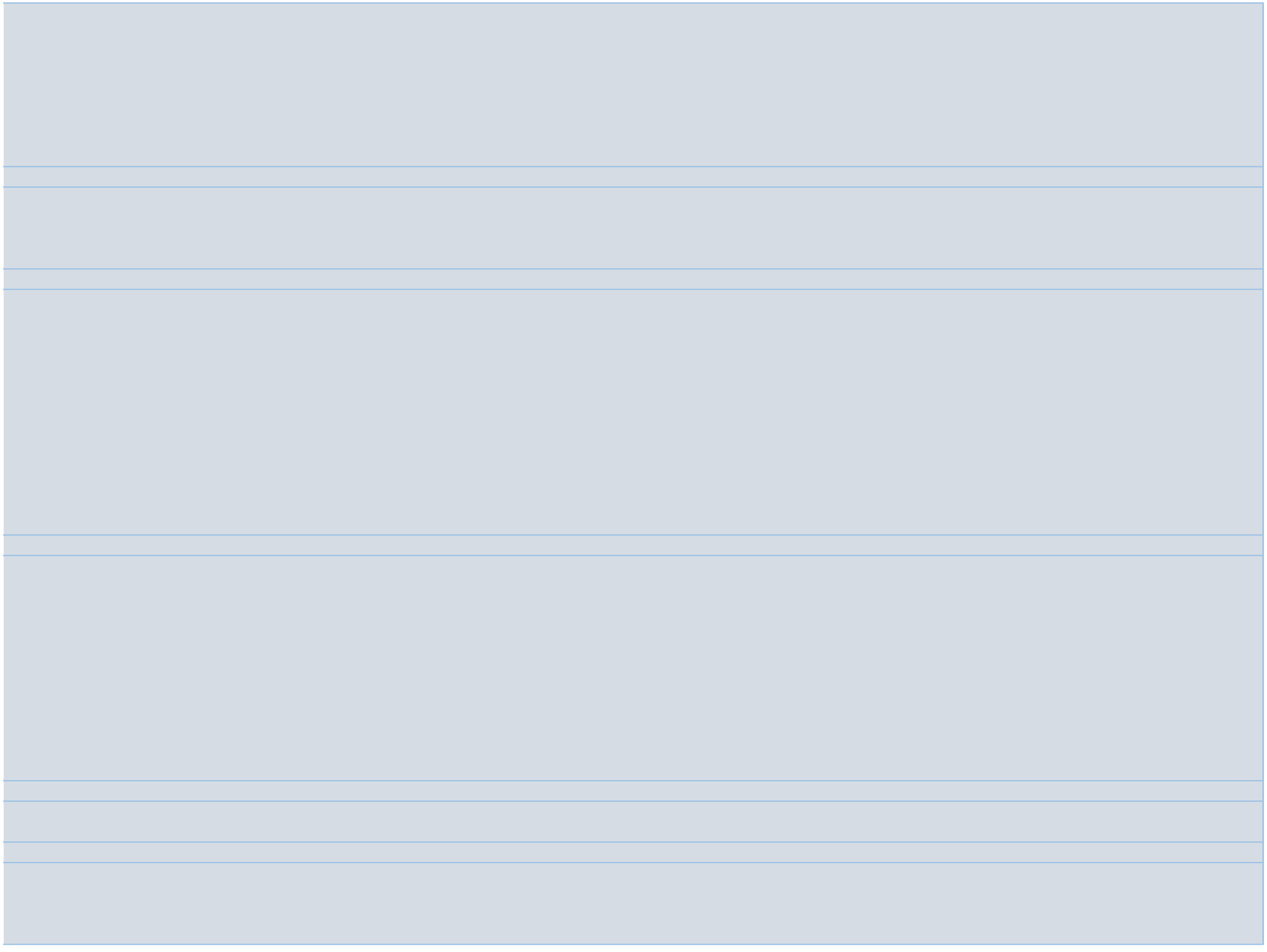


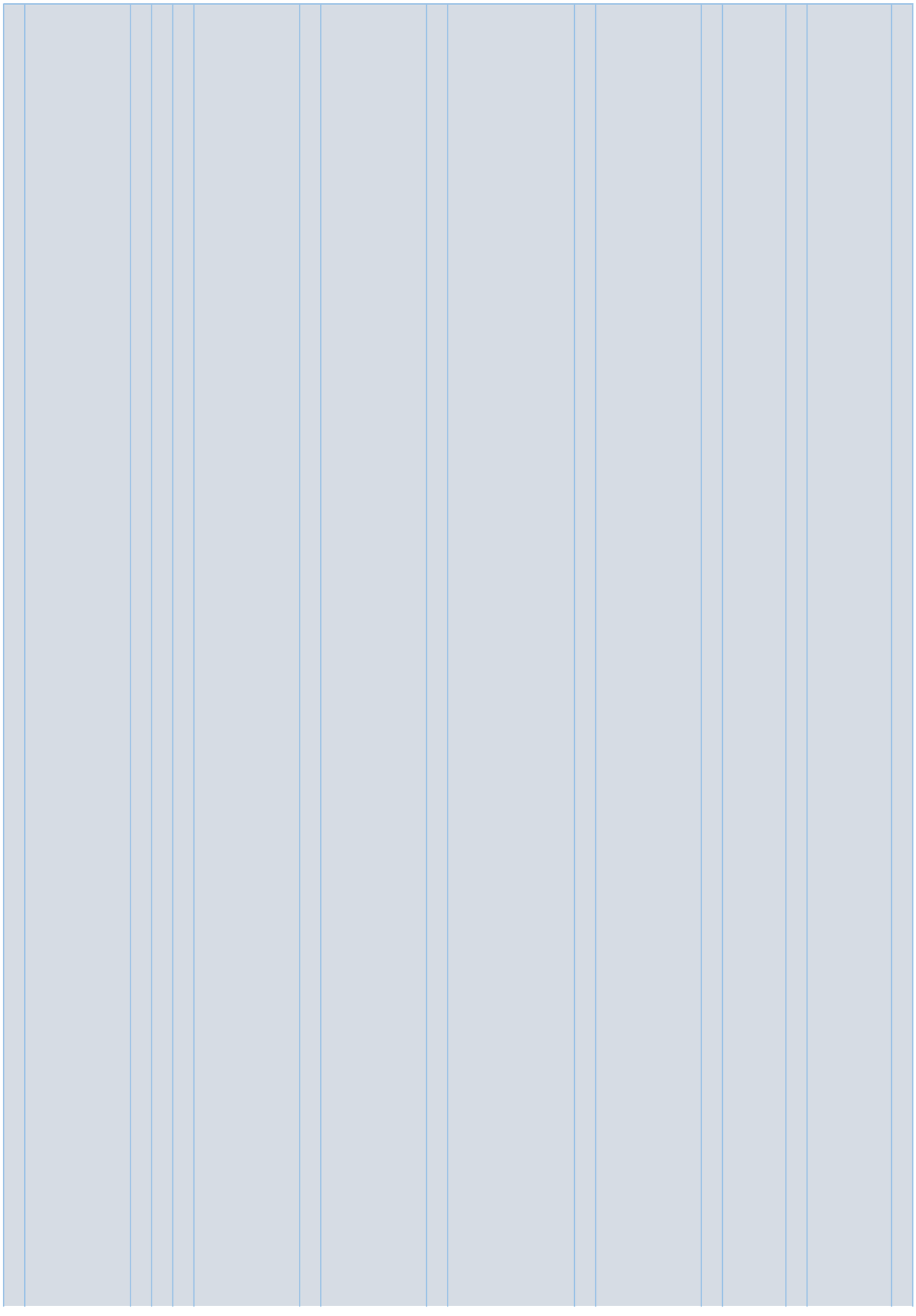


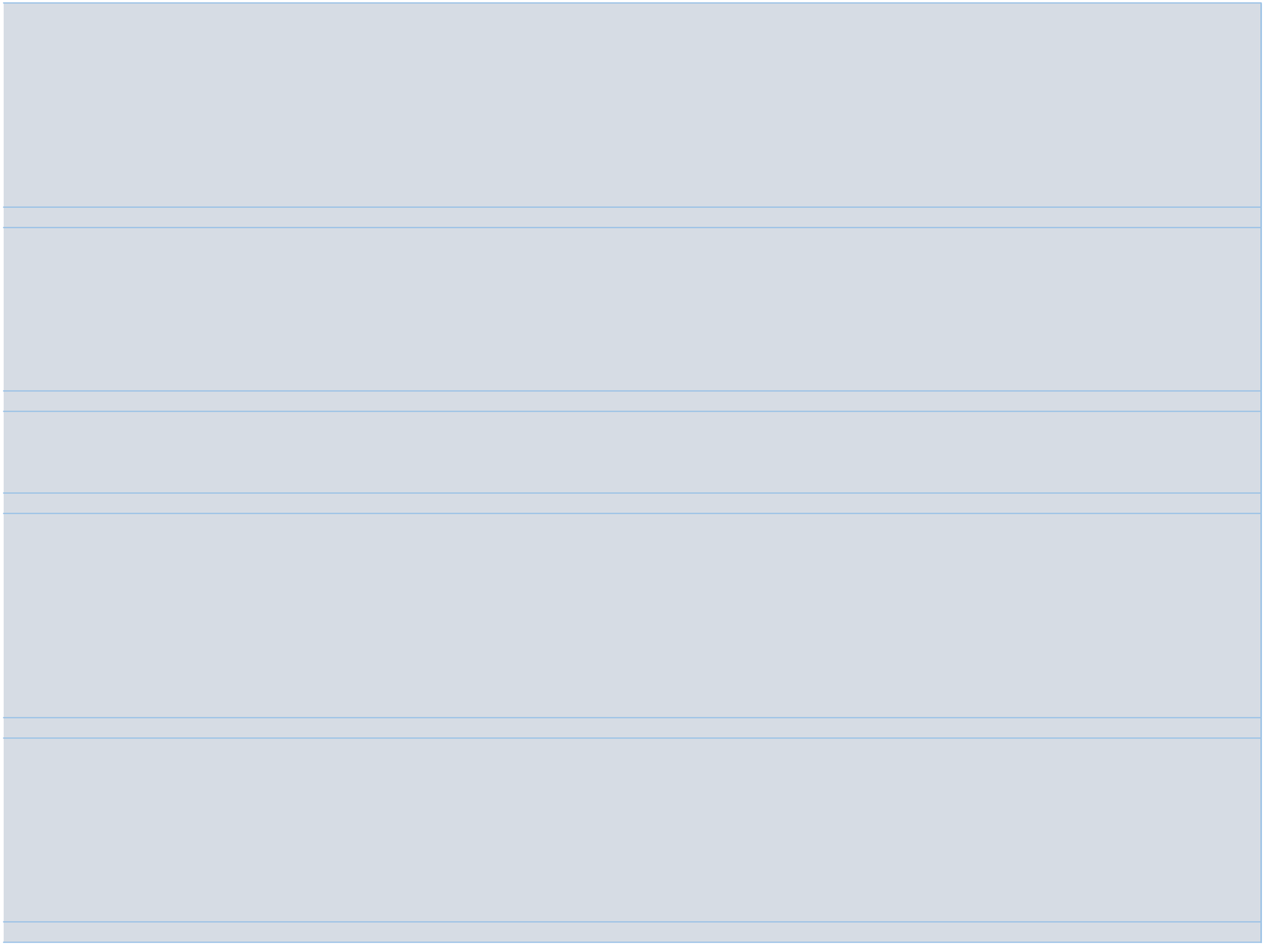


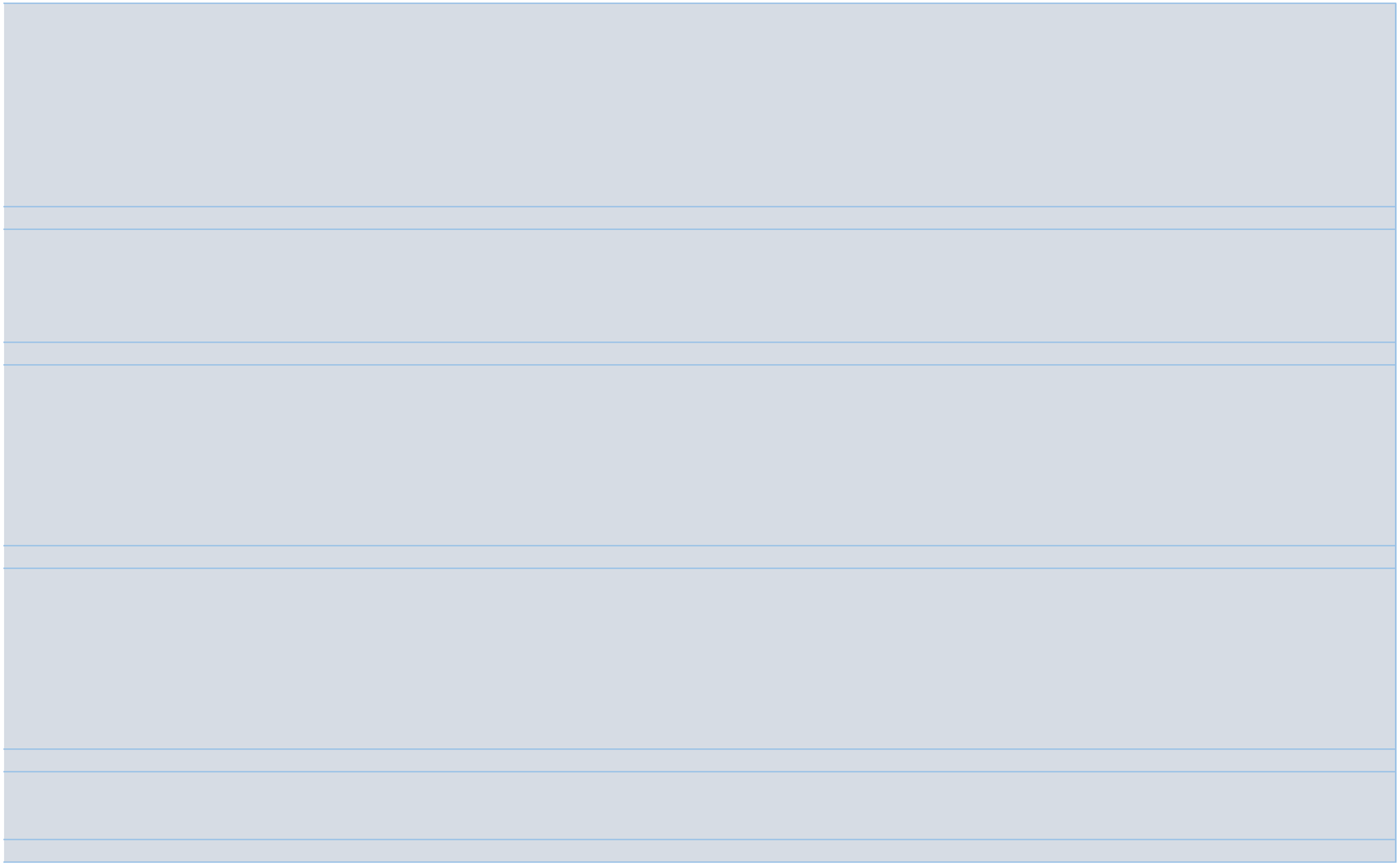


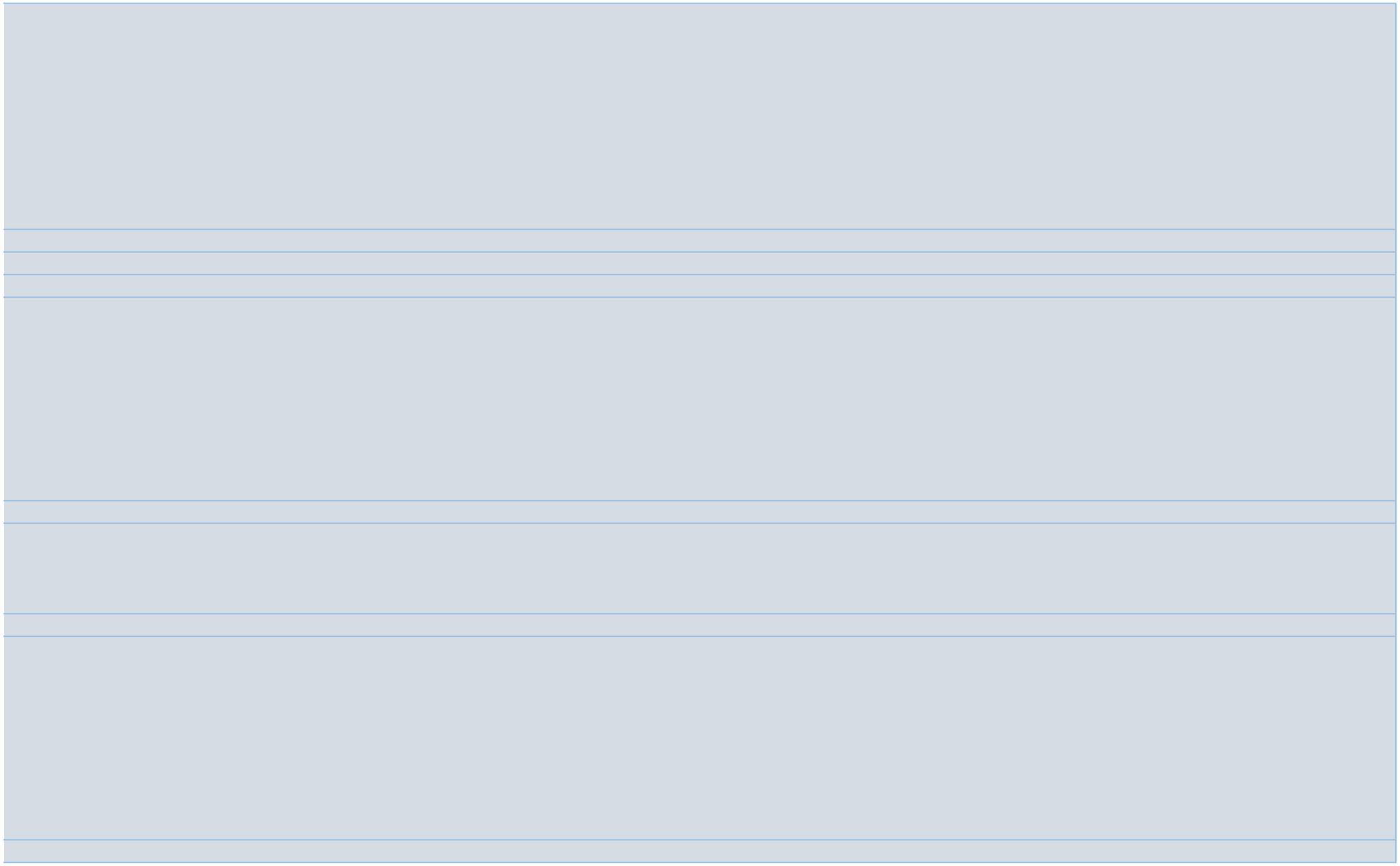


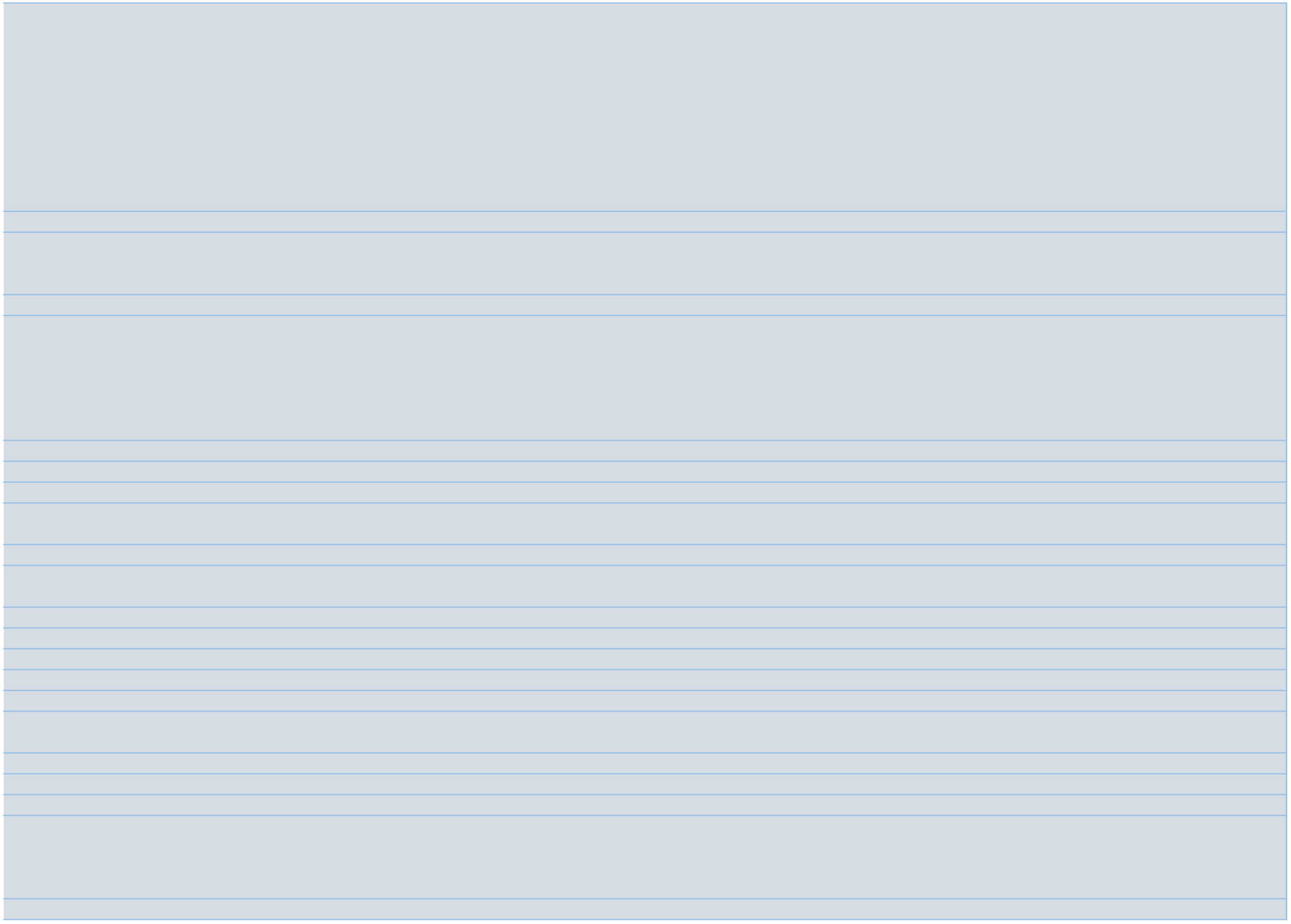


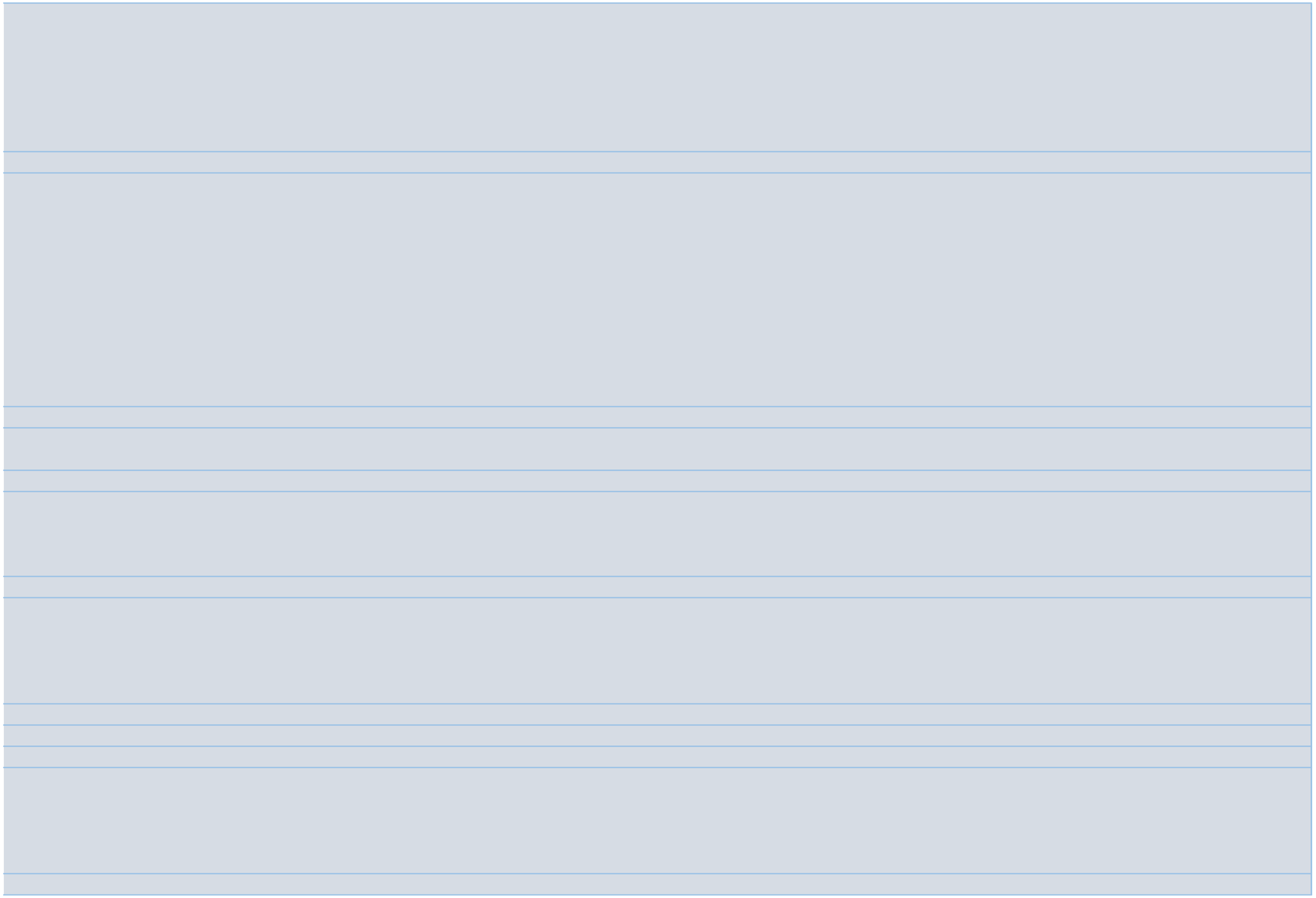


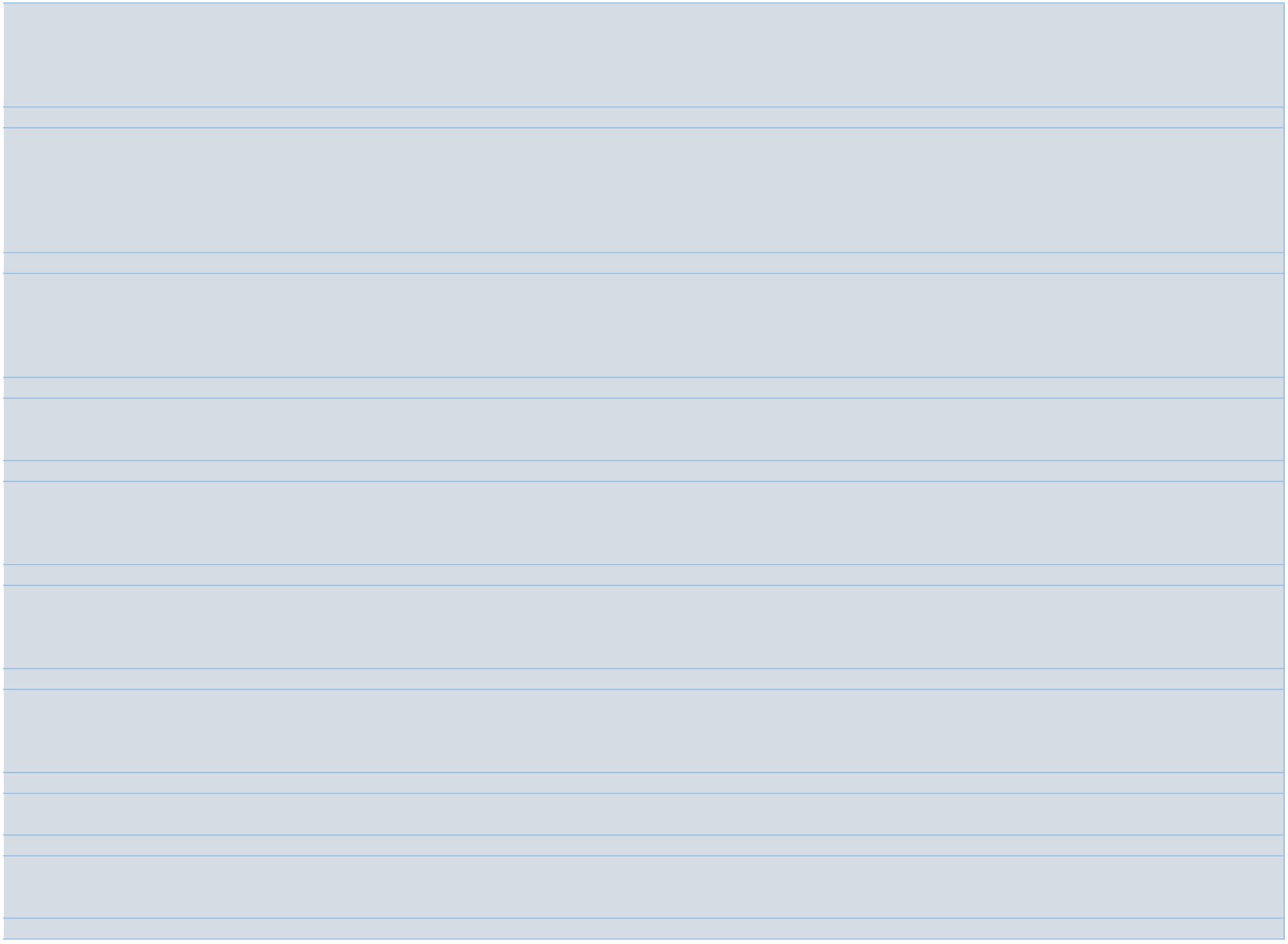


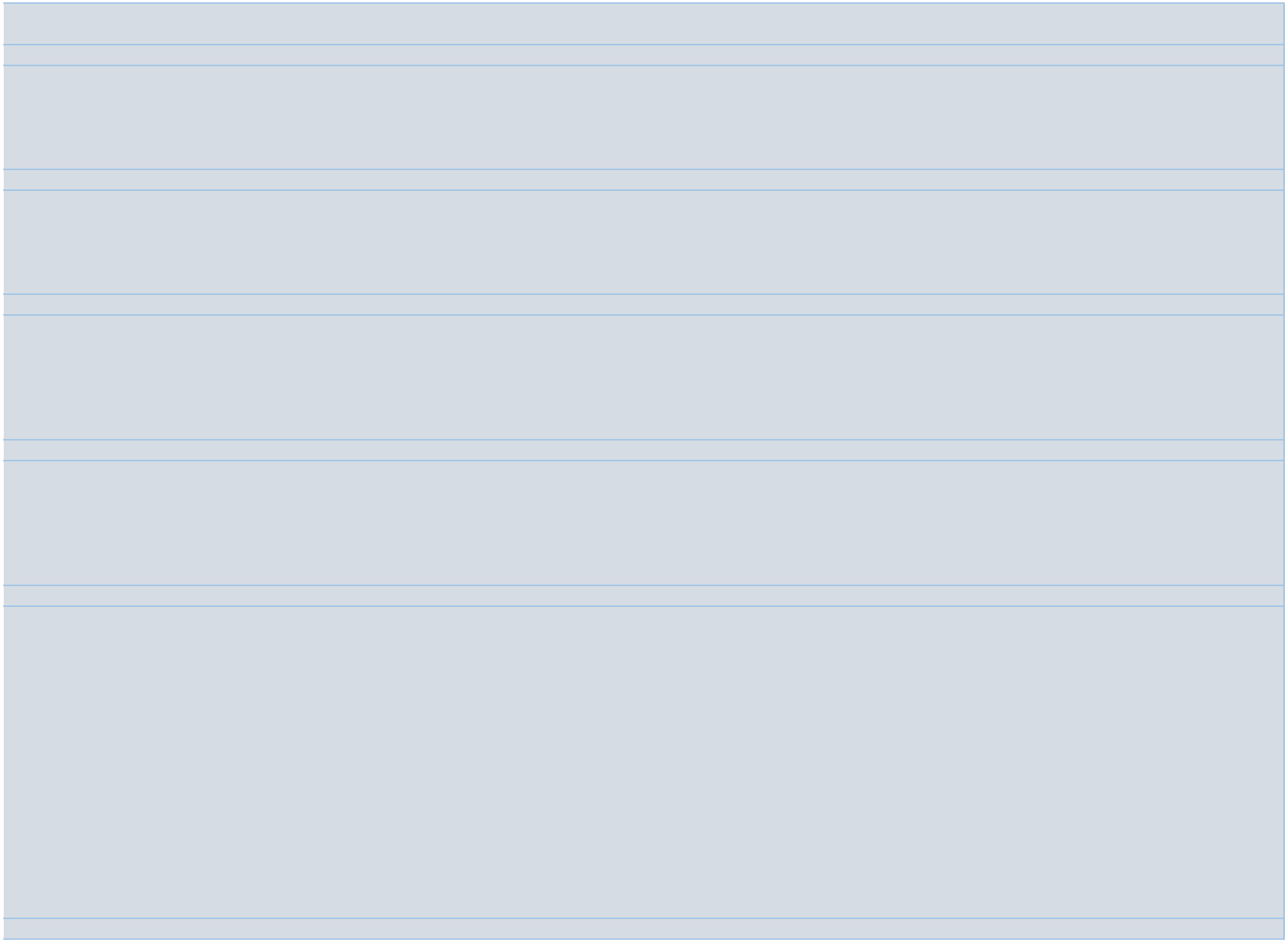


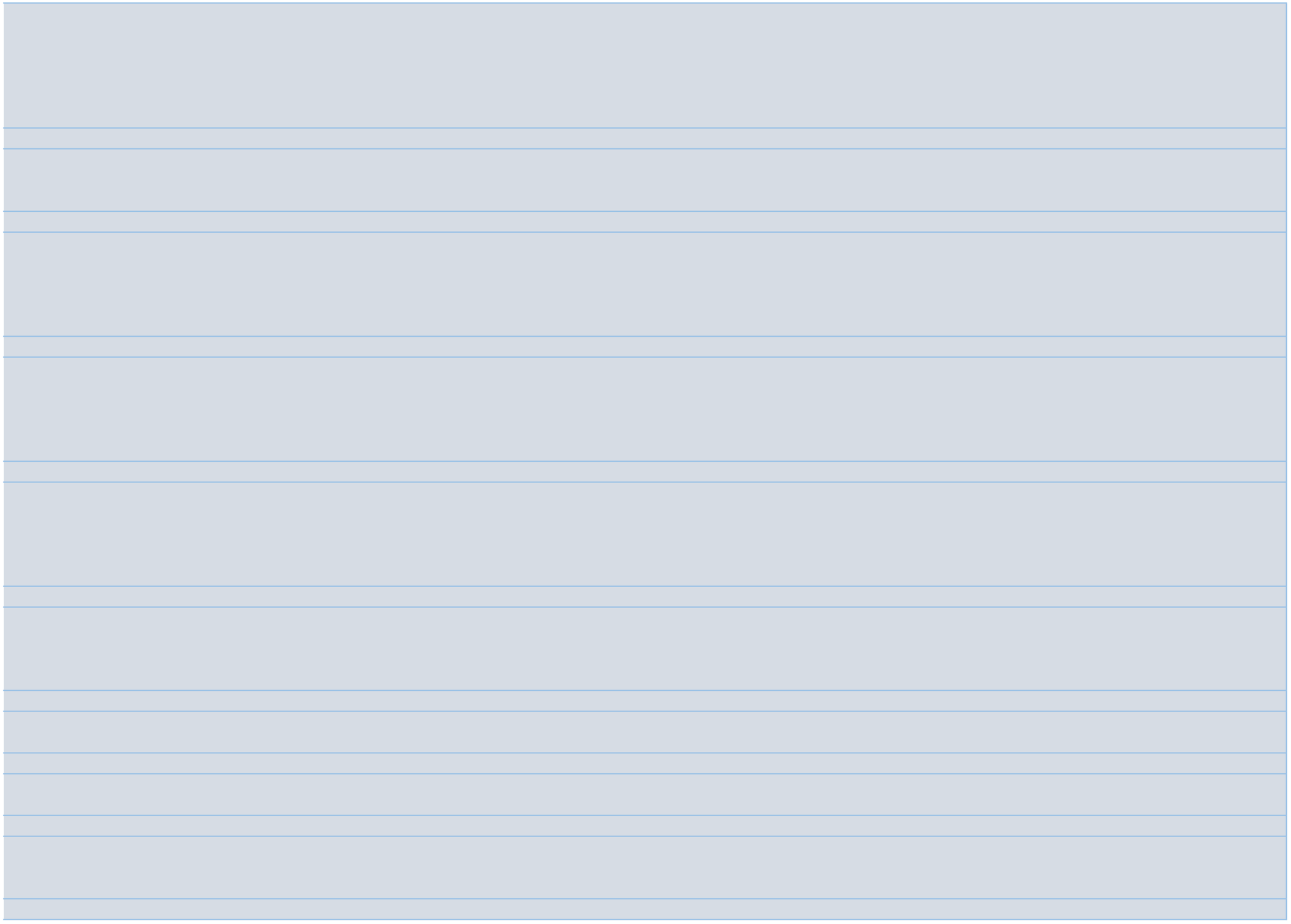


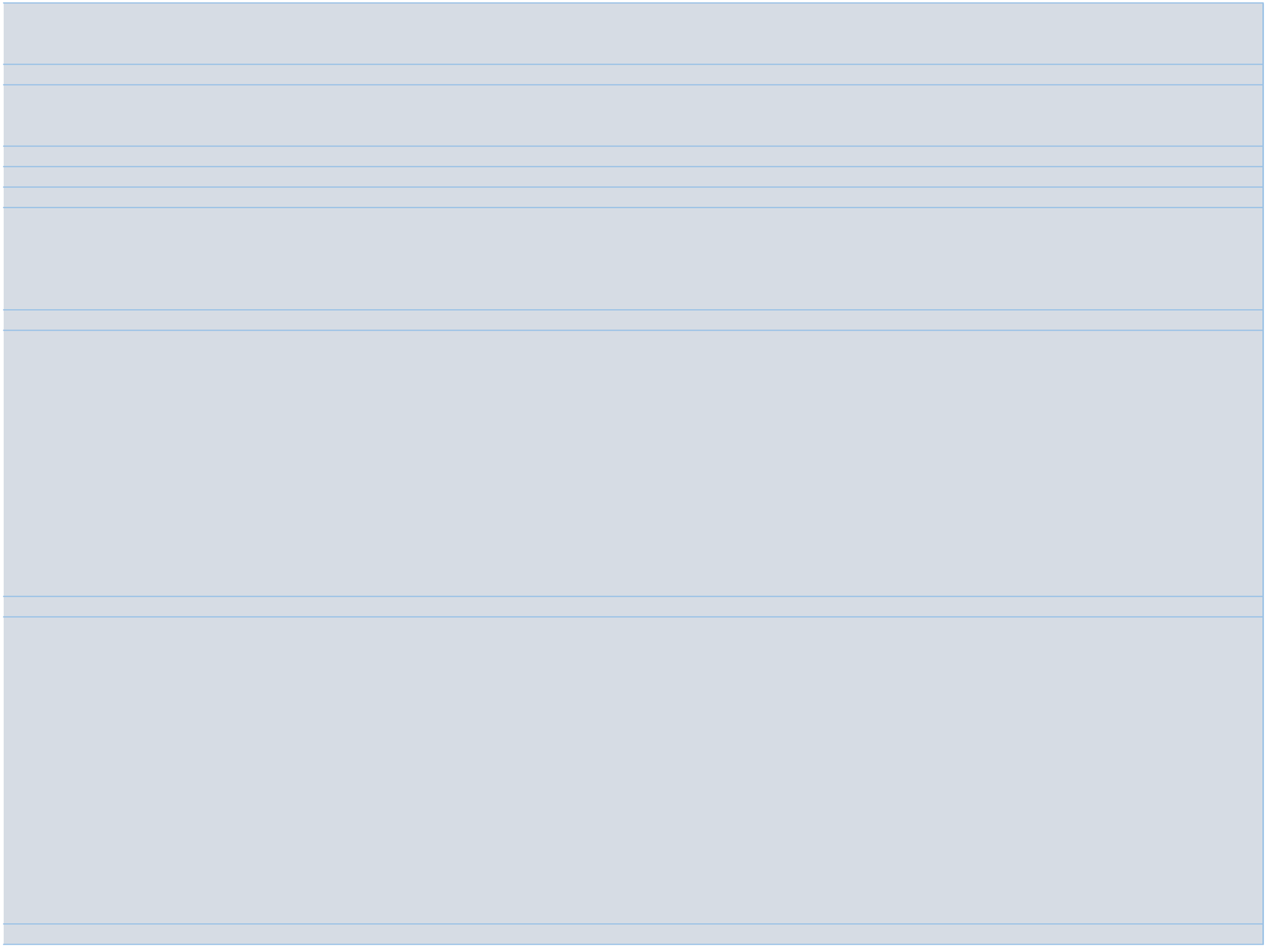


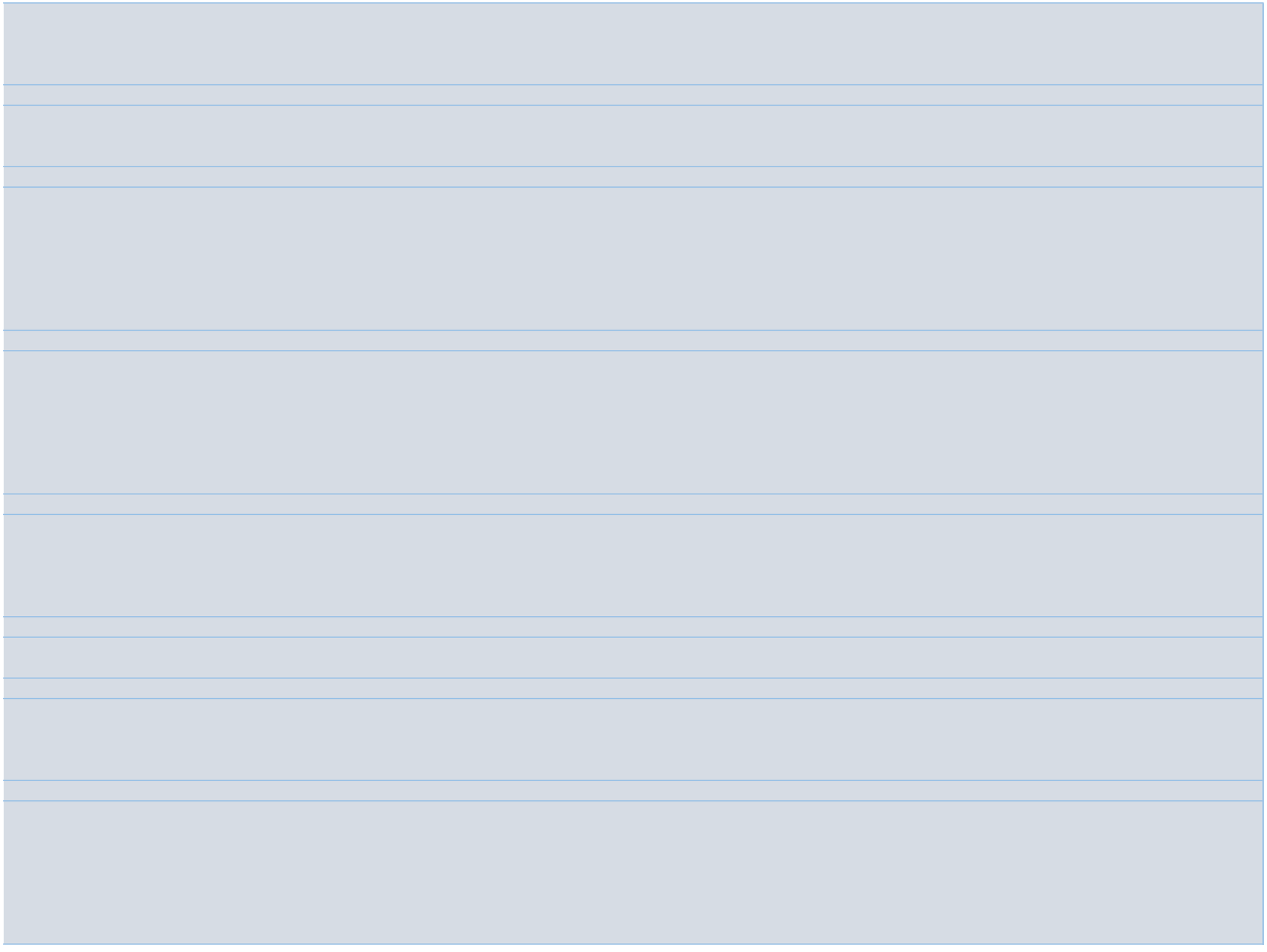


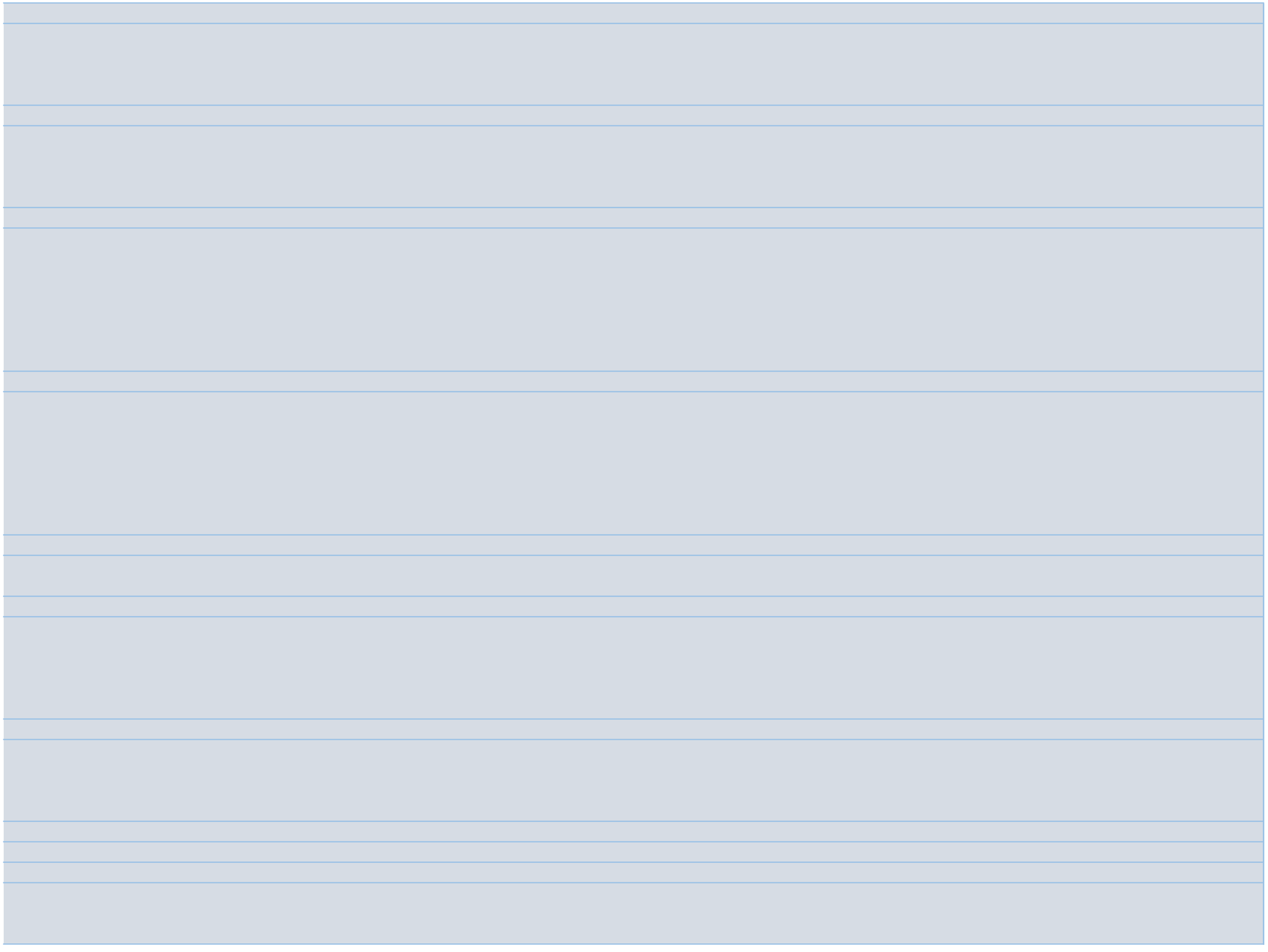


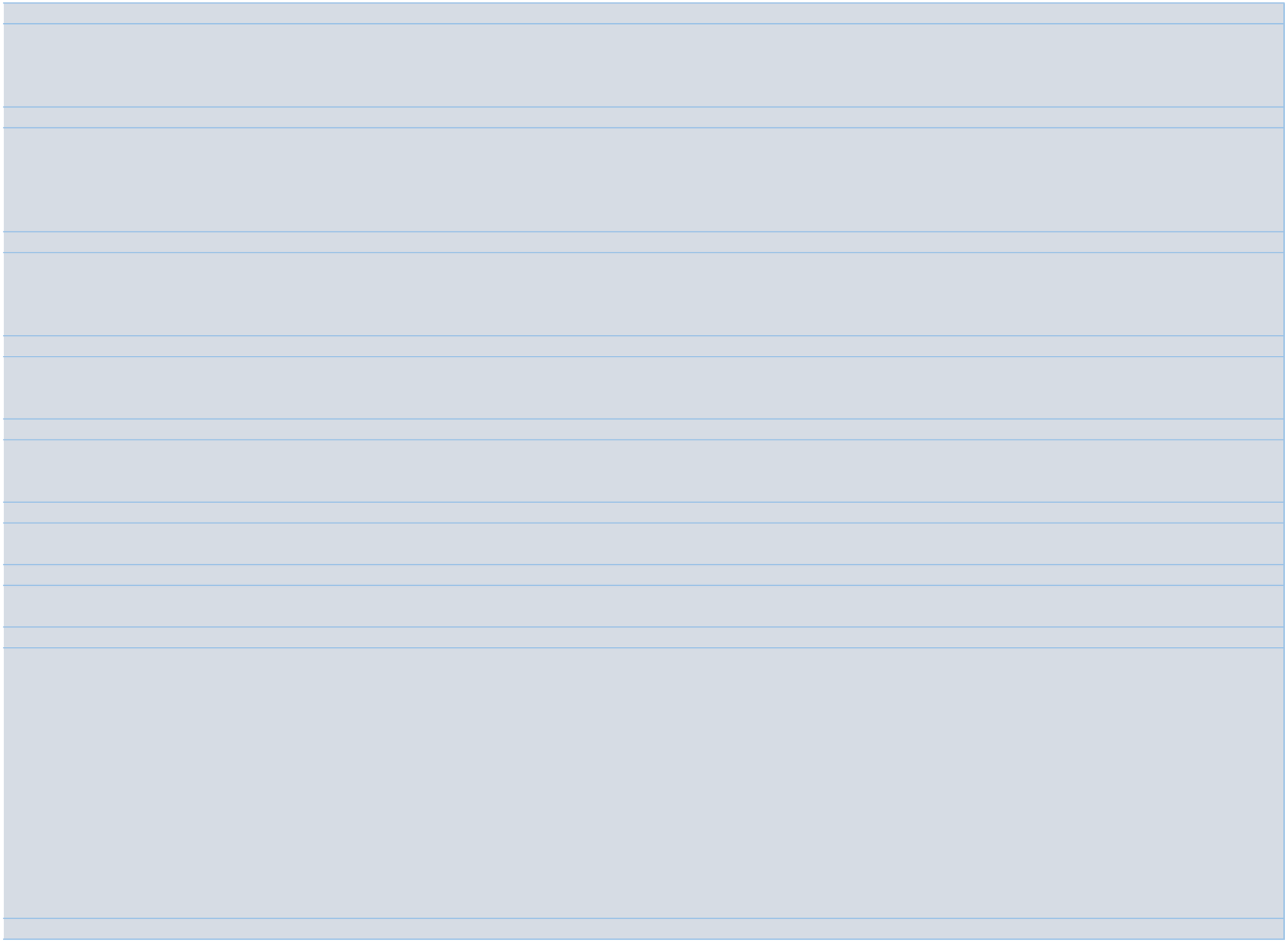


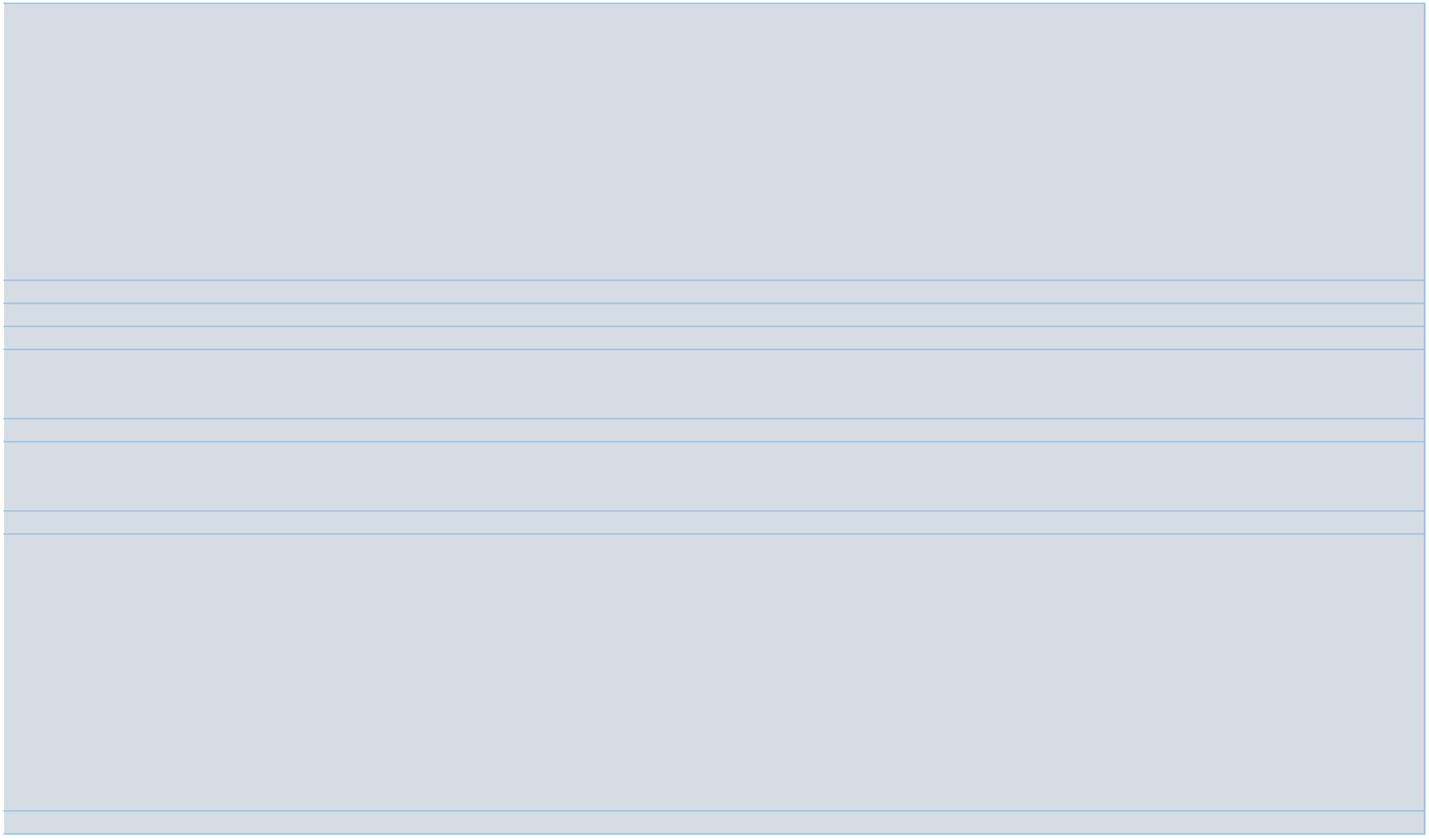


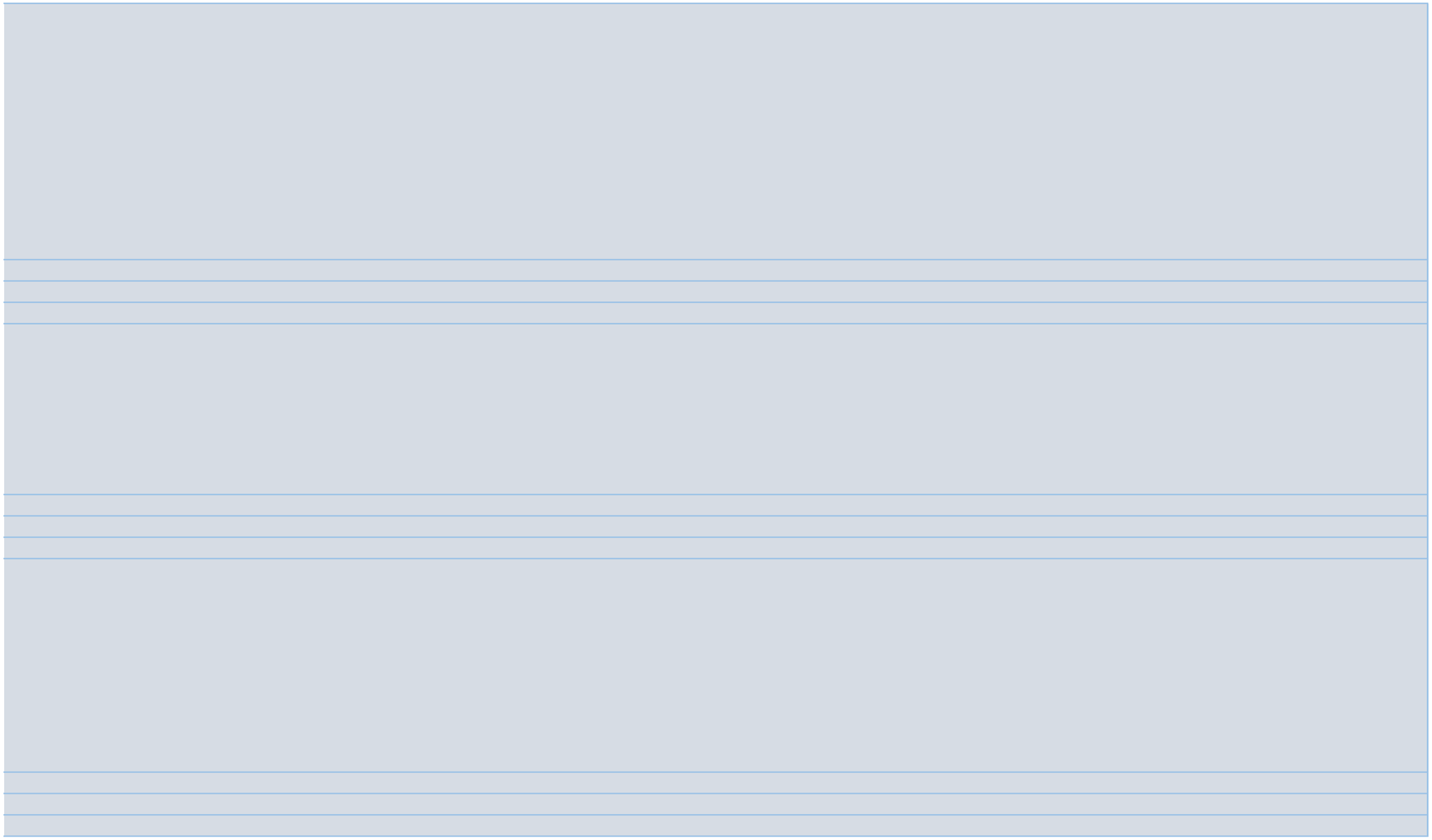


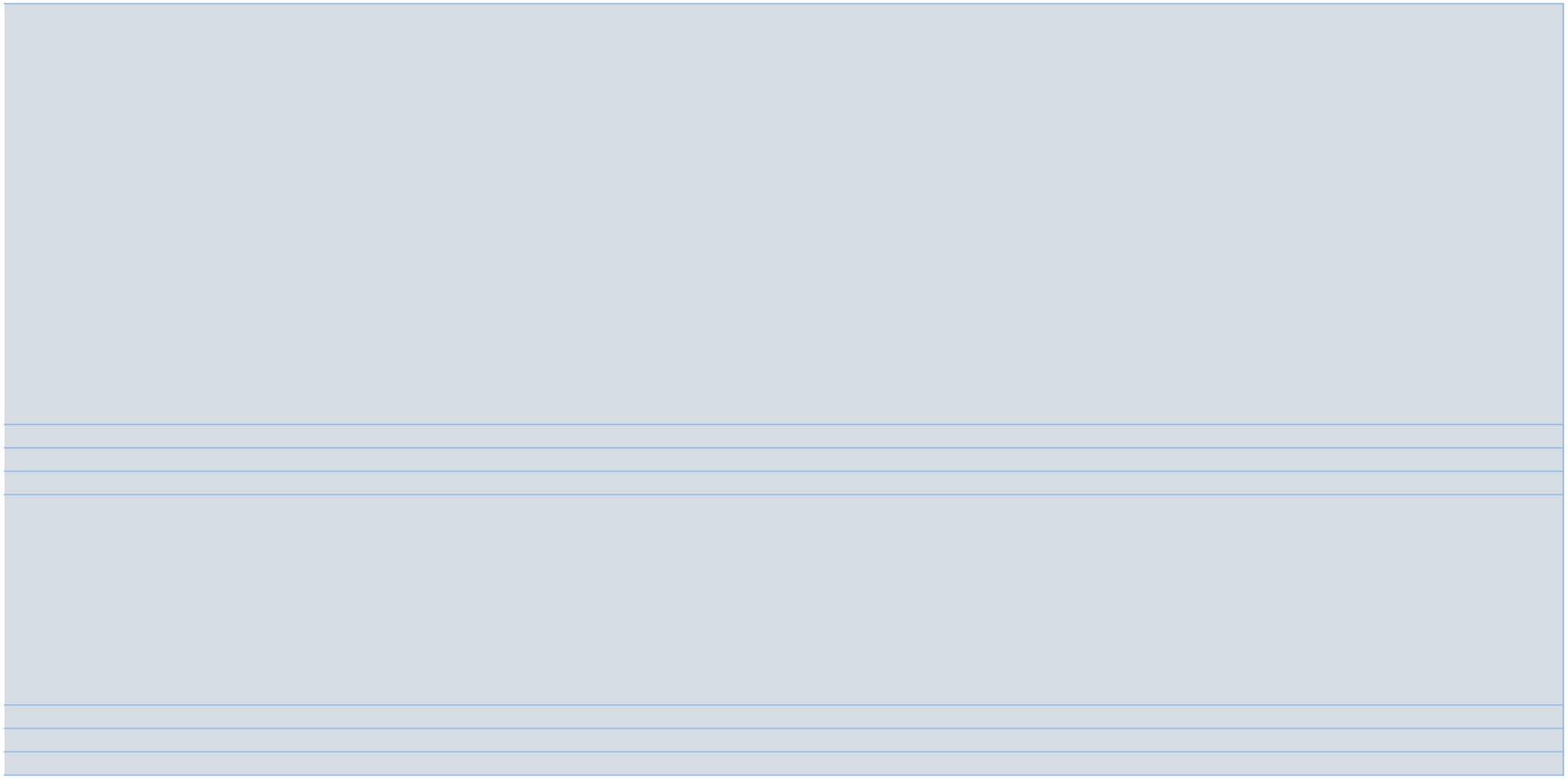


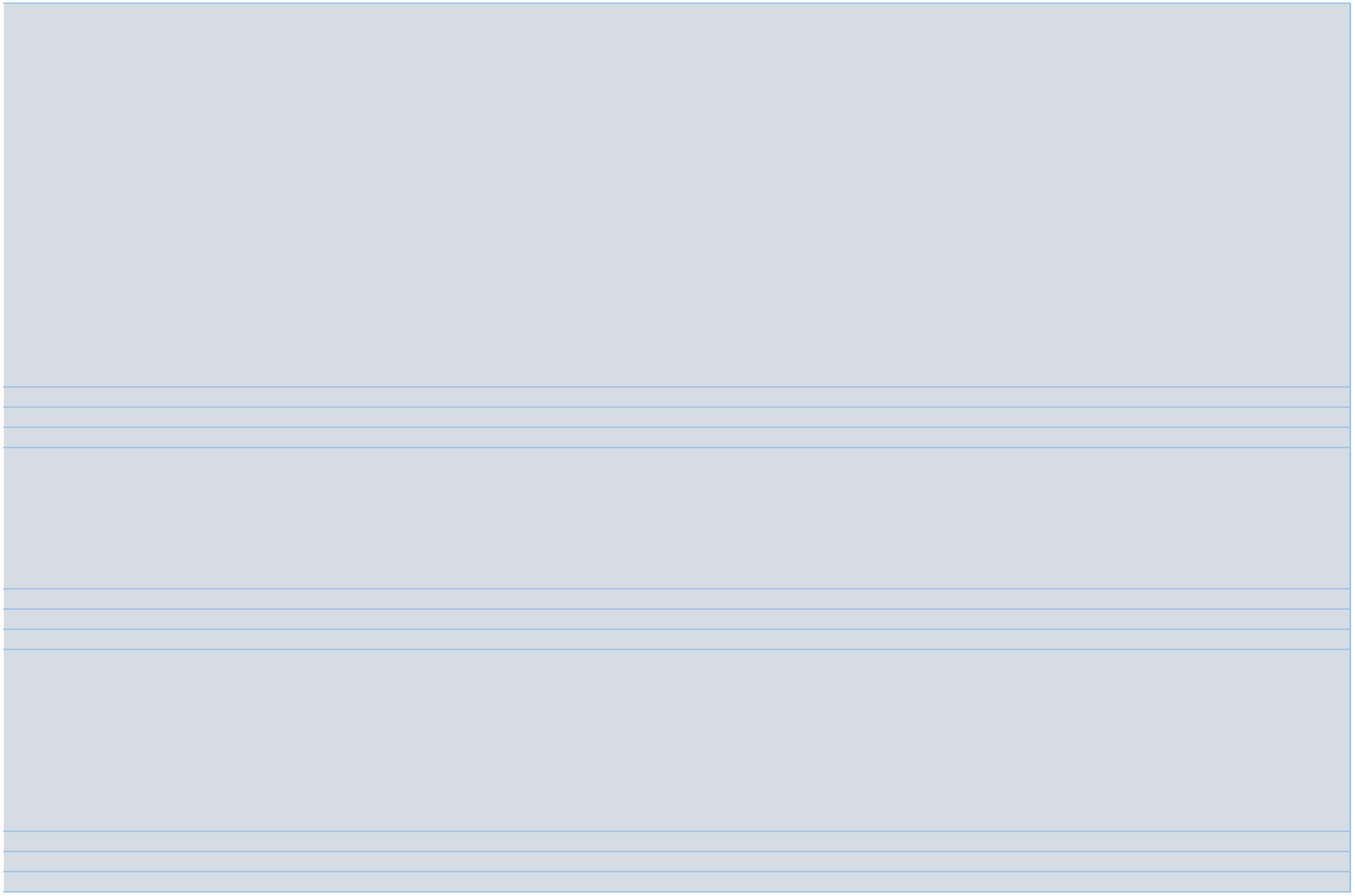


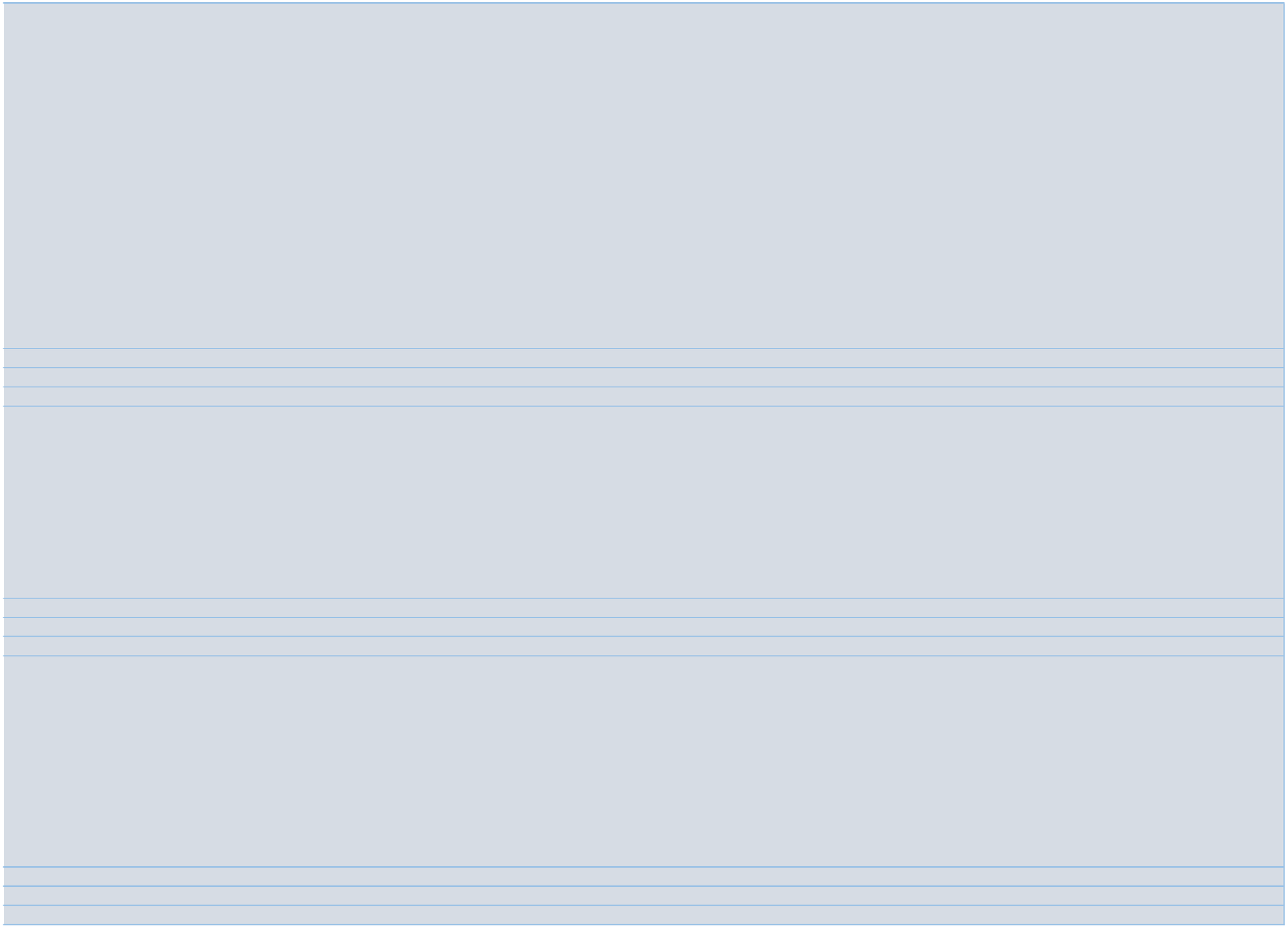


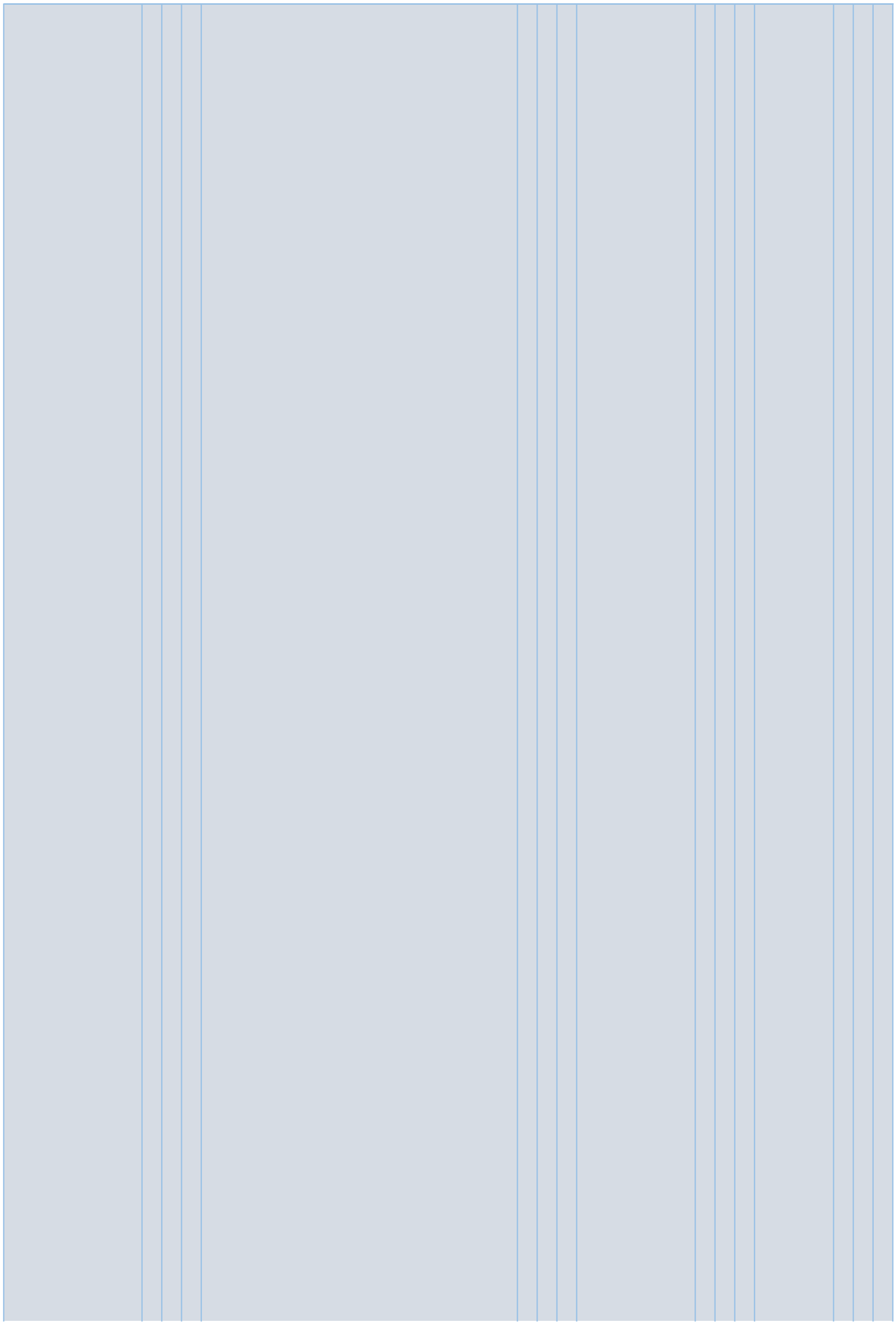












g invisible pixels in the images), to measure performance of Schneider Electric's communications and to improve them. For more details, please read our Privacy Policy.

e way the Volts Mode works.

id/door of the enclosure, which will physically press the overload stop. This is the method that is used in the Schneider Electric TeSys enclosed motor starters, such as the TeSys LE range.

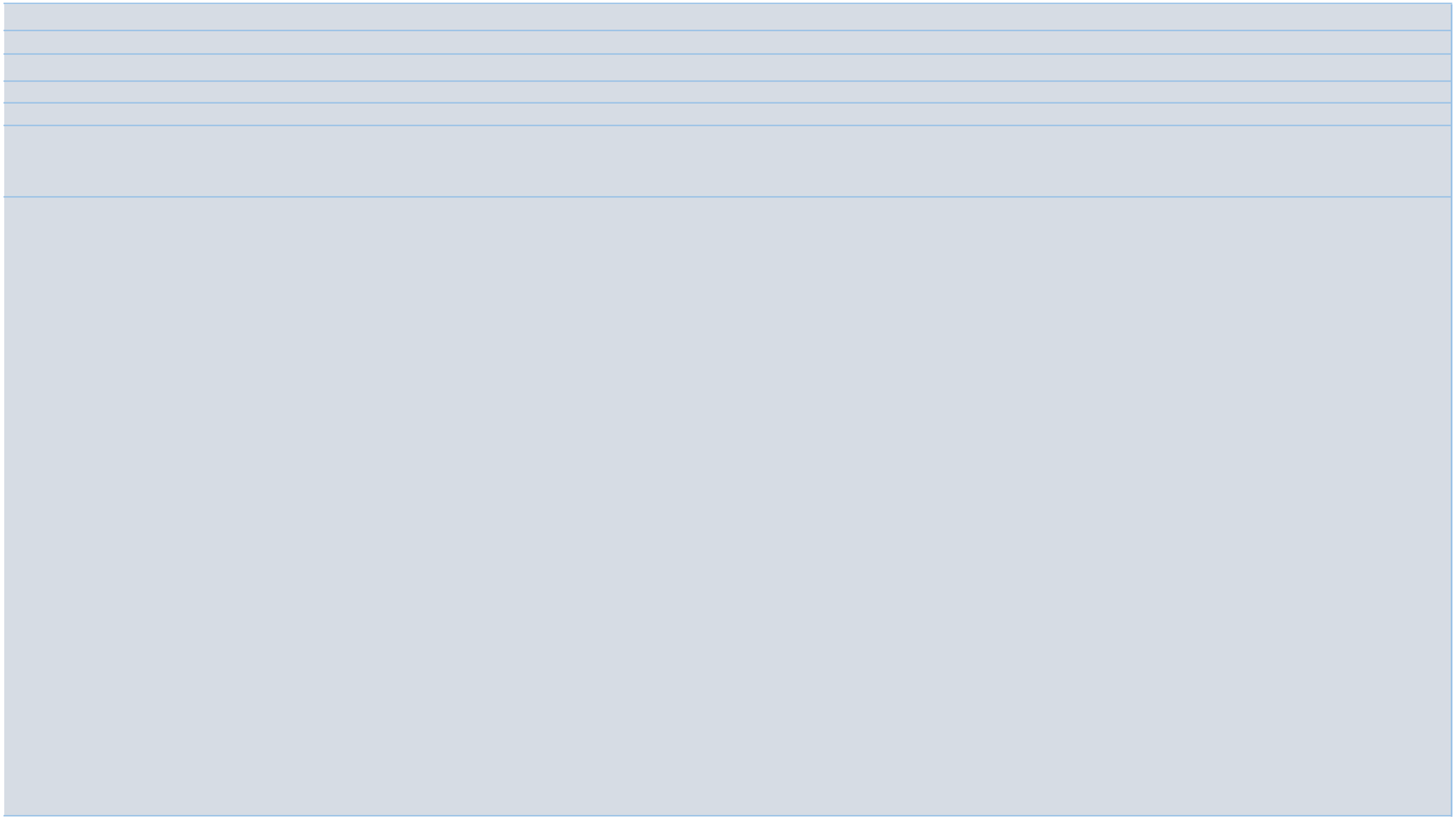
here will be no way of stopping the motor without disconnecting the supply.

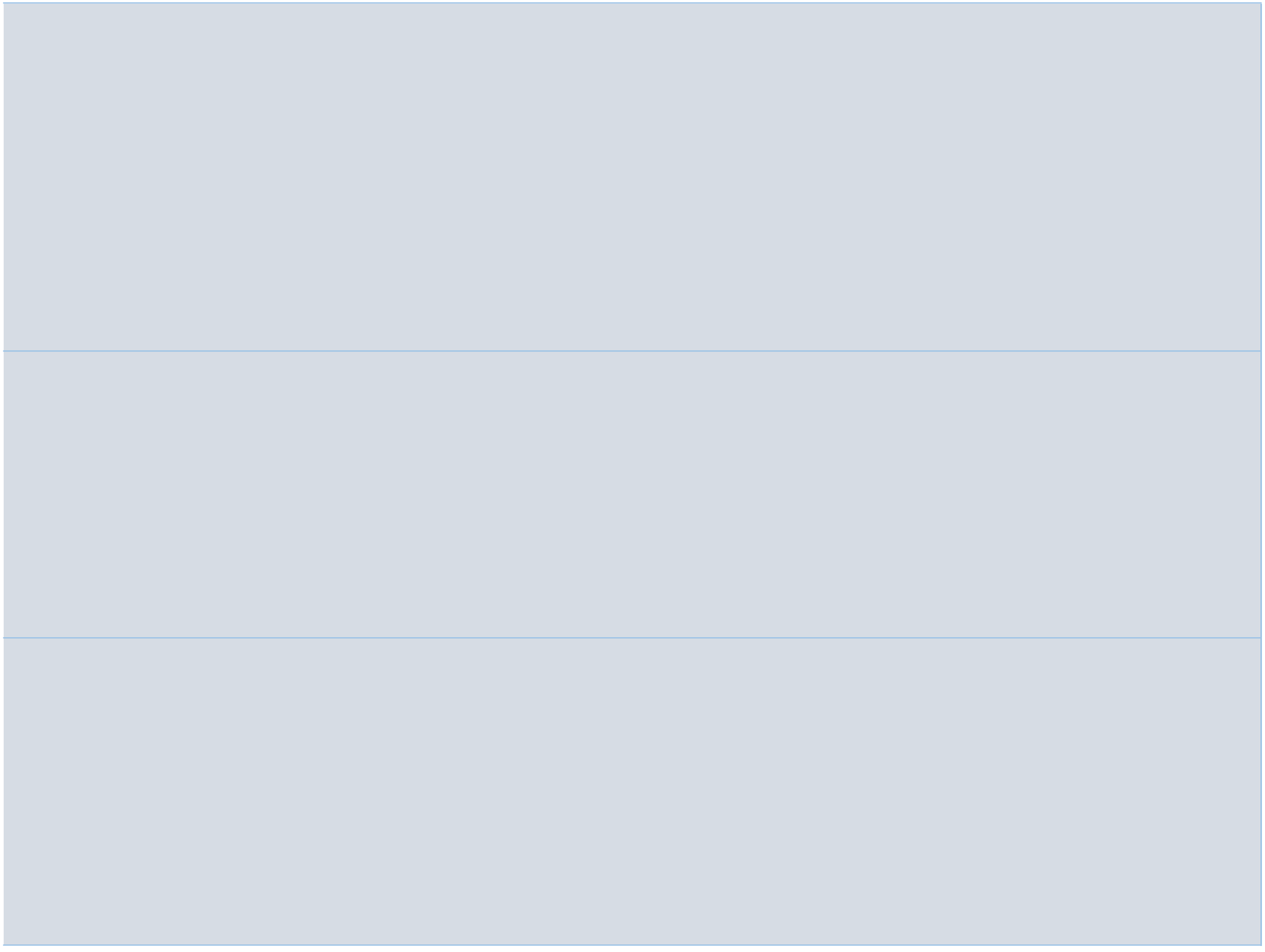
**ion is provided.**
**the plant it may not be appropriate, other Emergency Stop facilities may be necessary, particularly in high risk applications. Consult you safety consultant.**

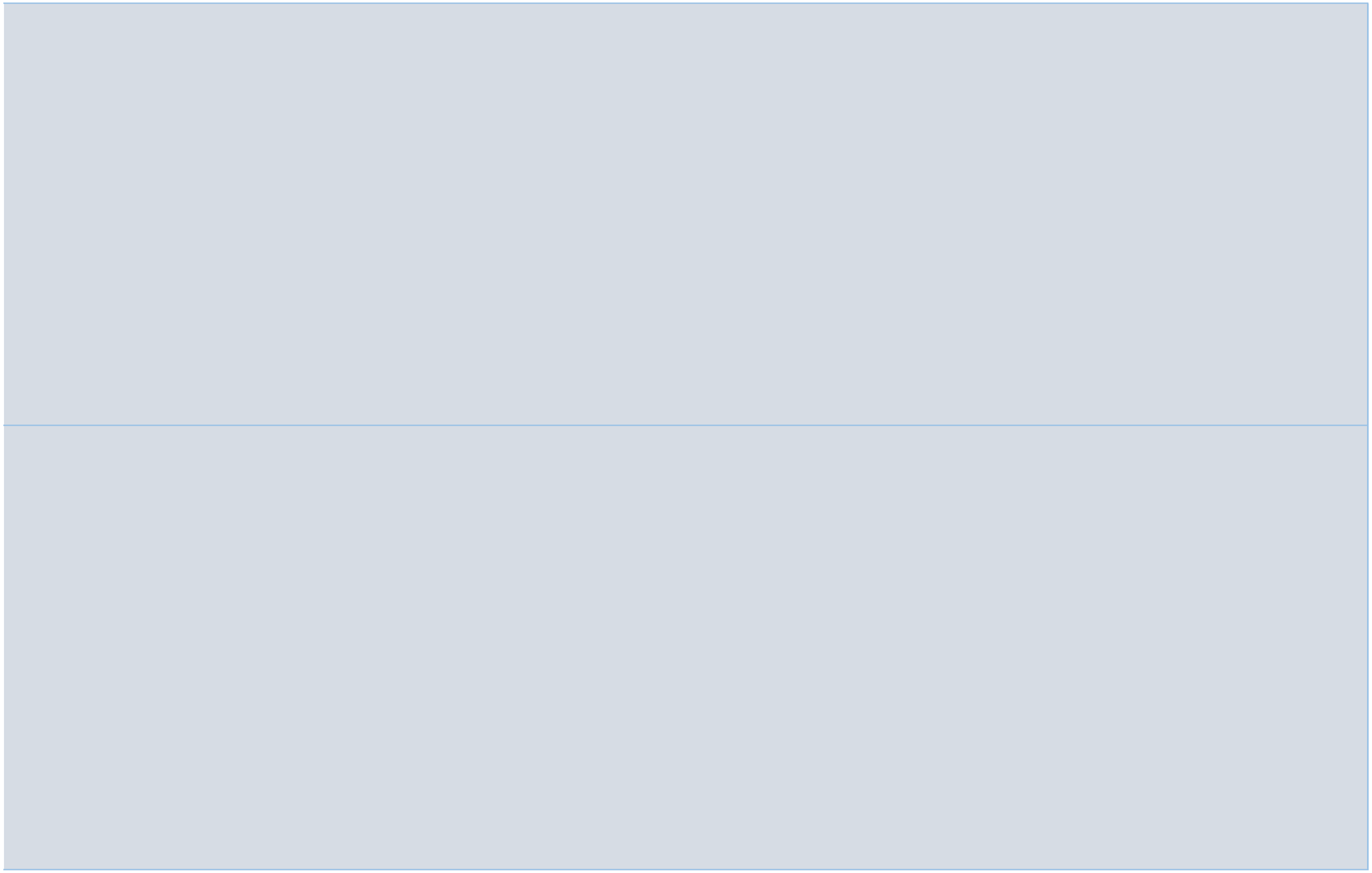
use different numbering systems.

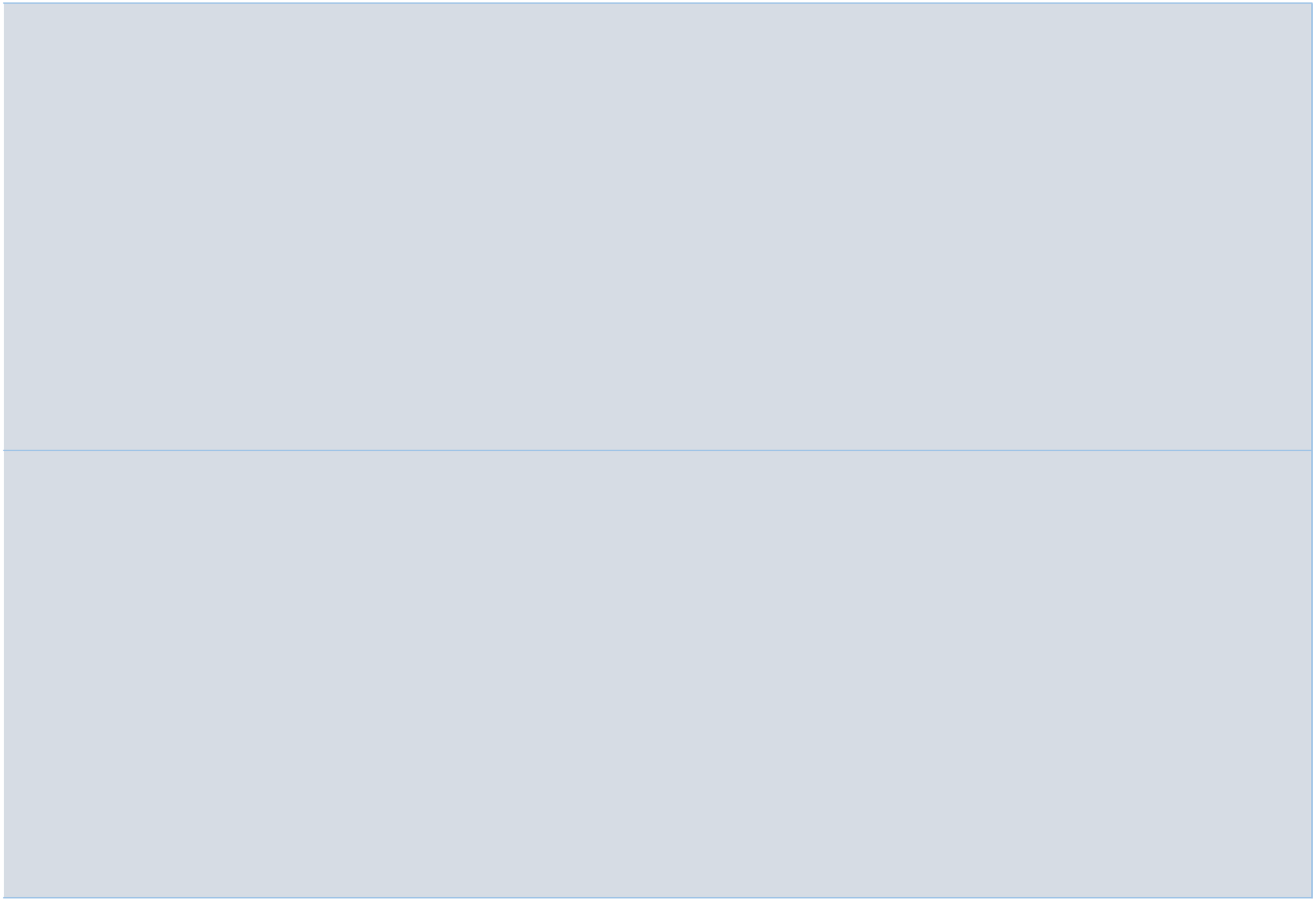
2 on contactor to 96 on overload. The diagrams provided in the attached PDF file do not relate to such TeSys K systems unless the 2 right hand pins are first removed. These pins are specially weakened

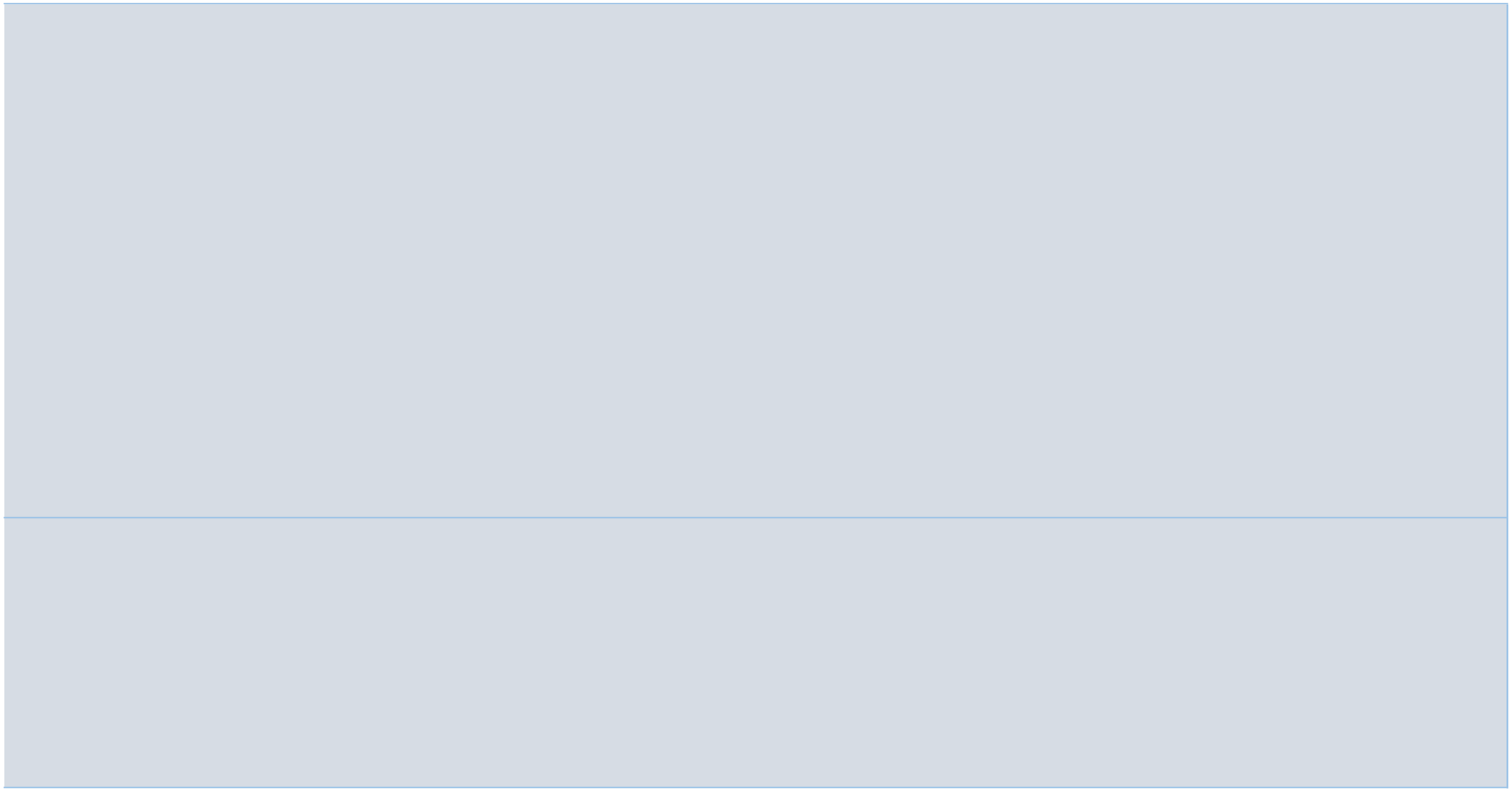
lletin or on the equipment to warn of hazards or to call attention to information that clarifies or simplifies a procedure.

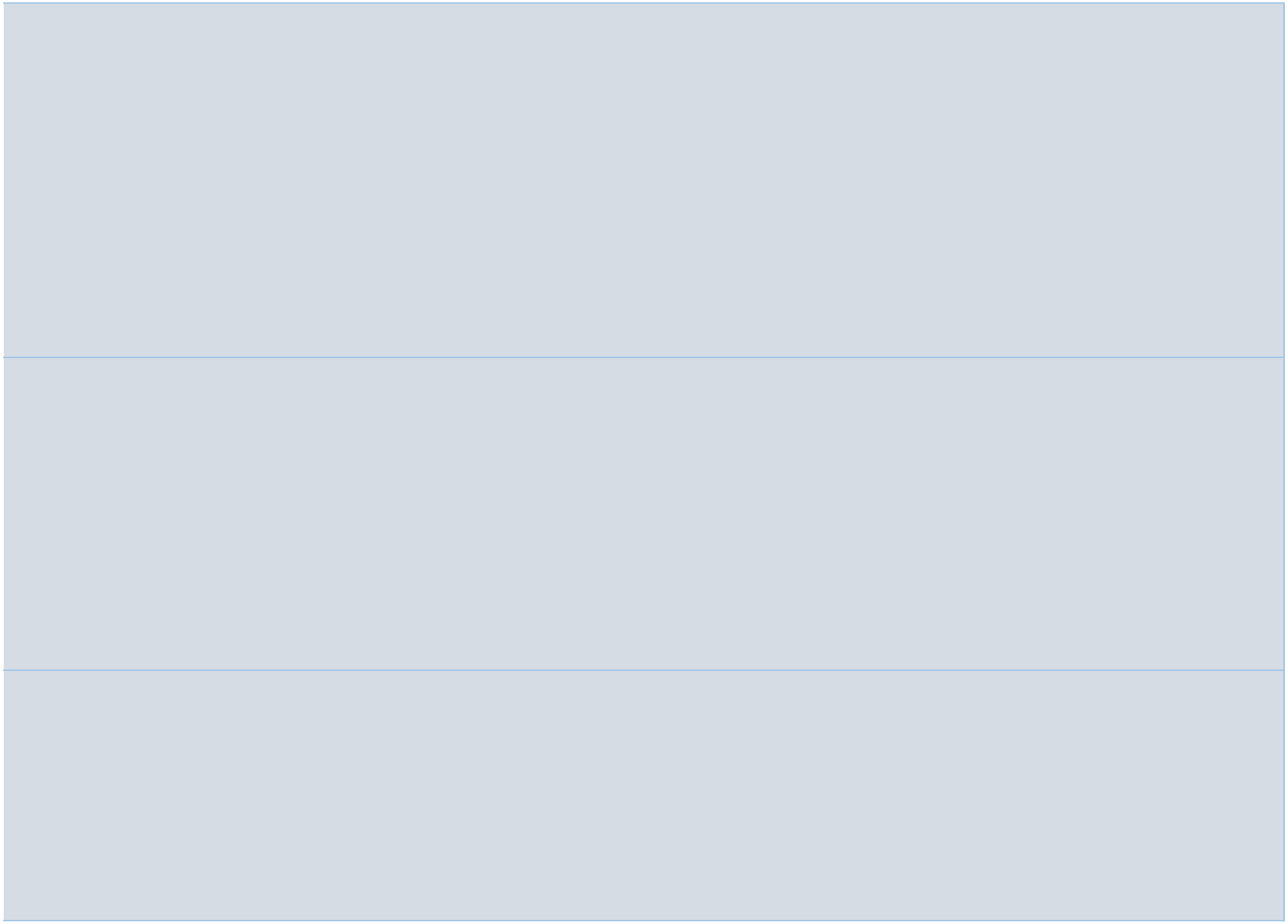


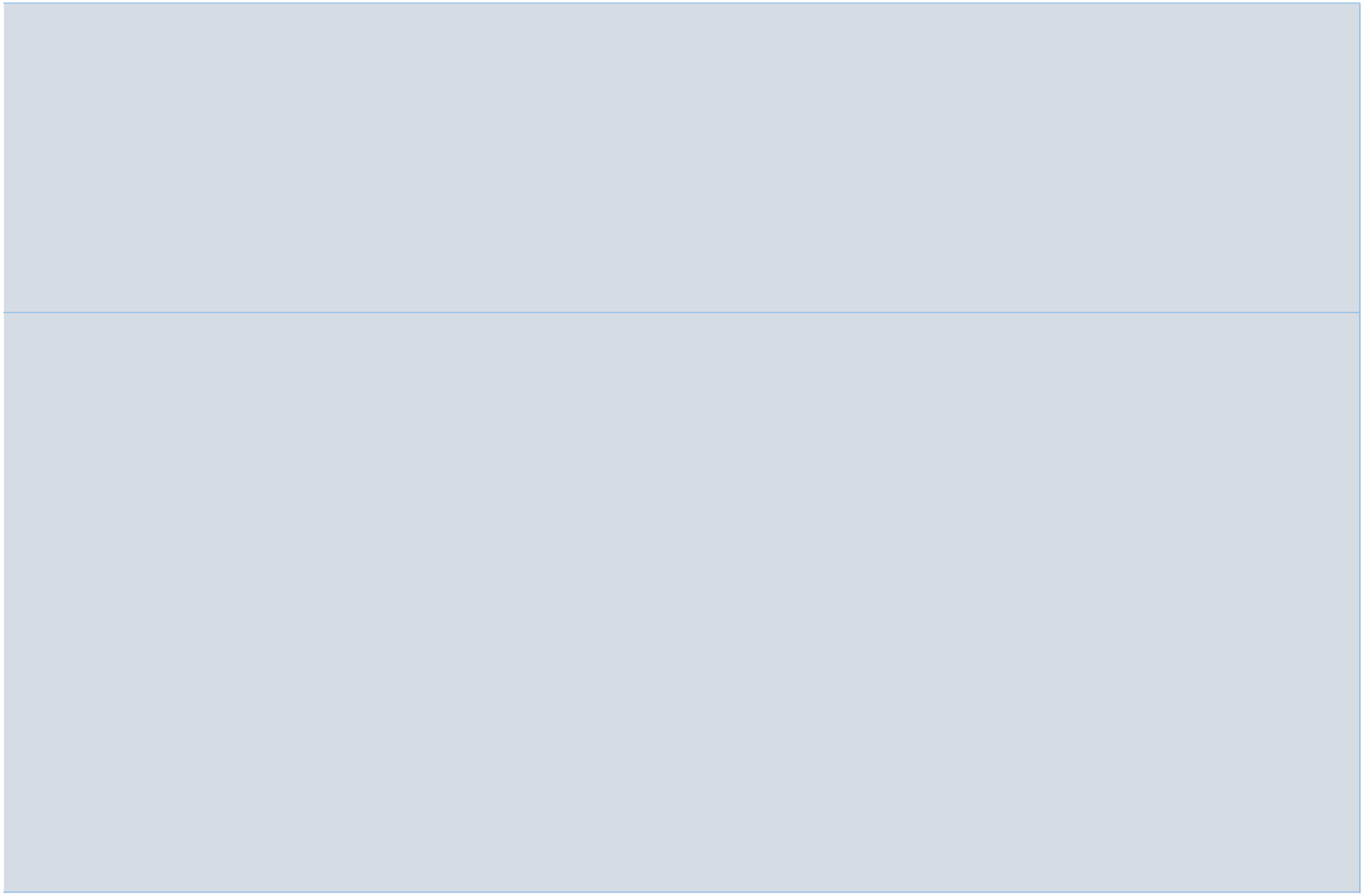


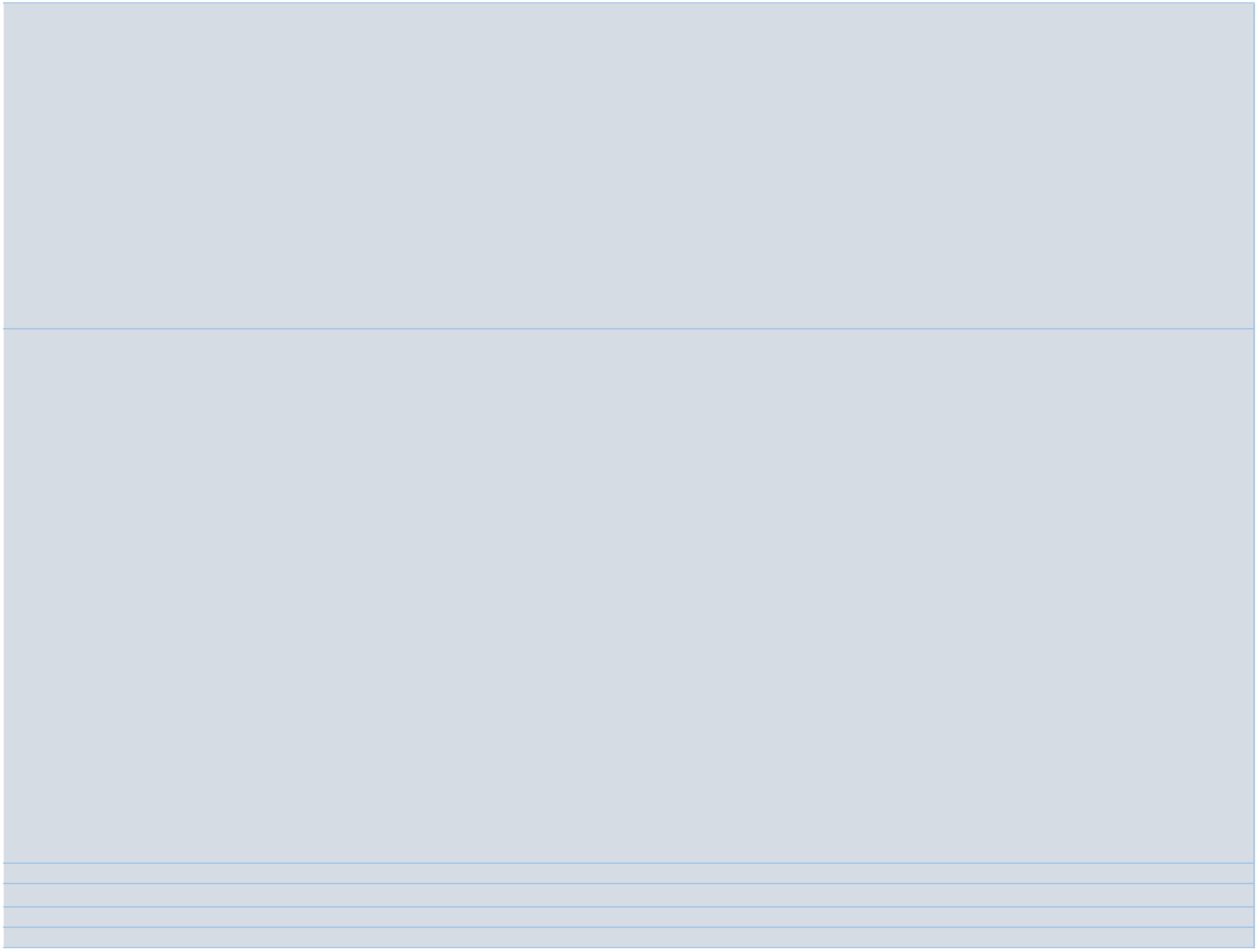




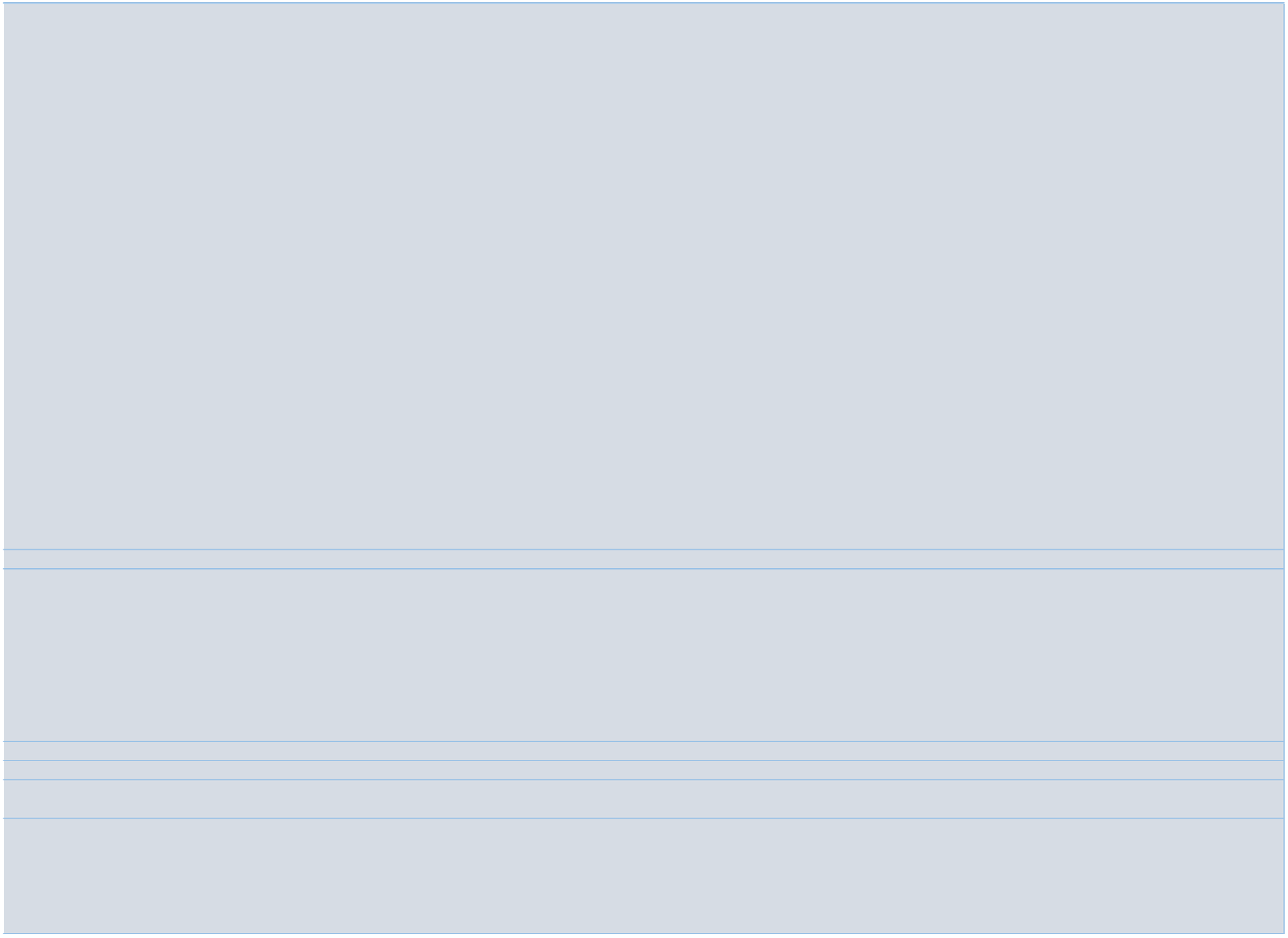






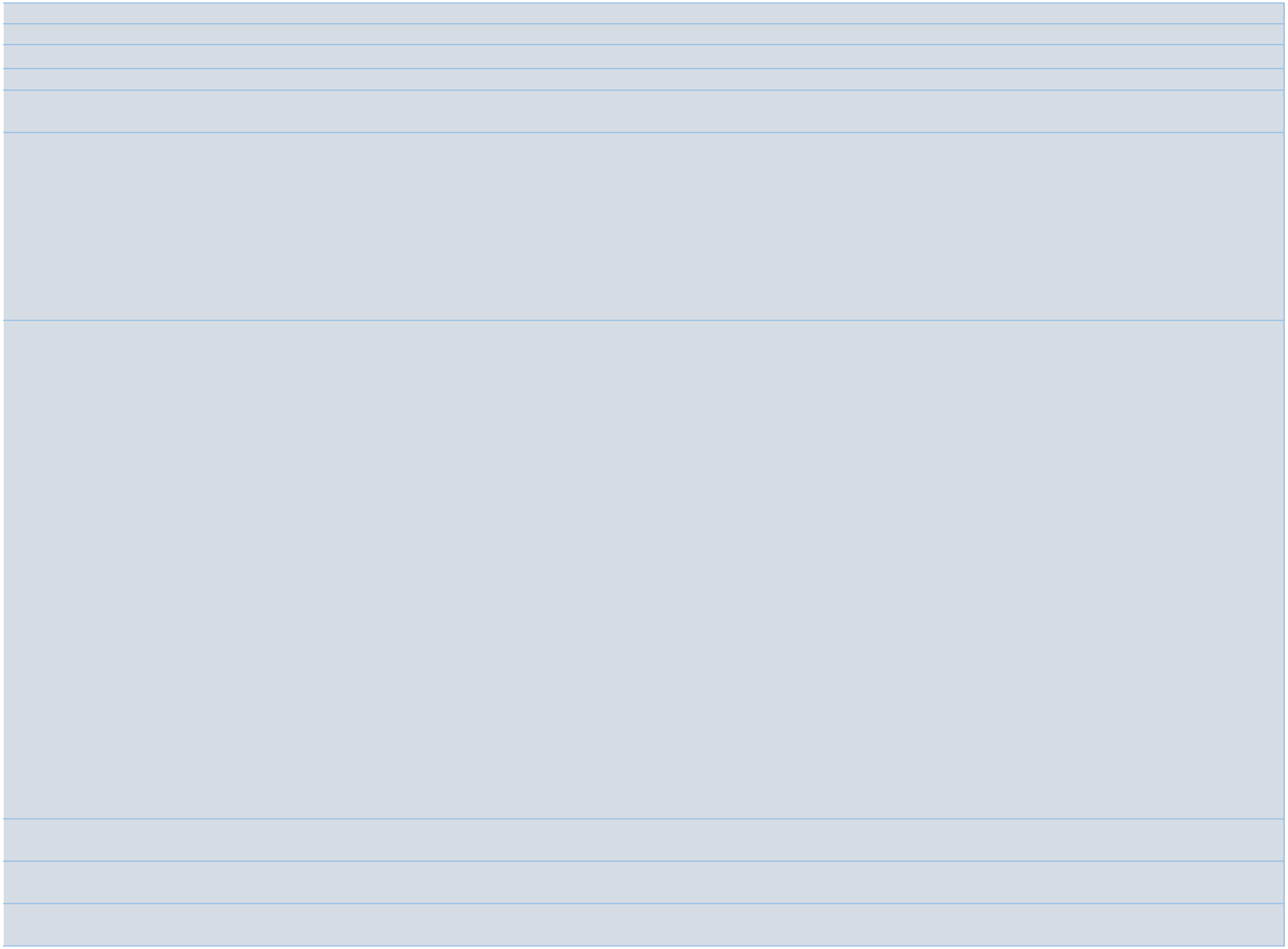


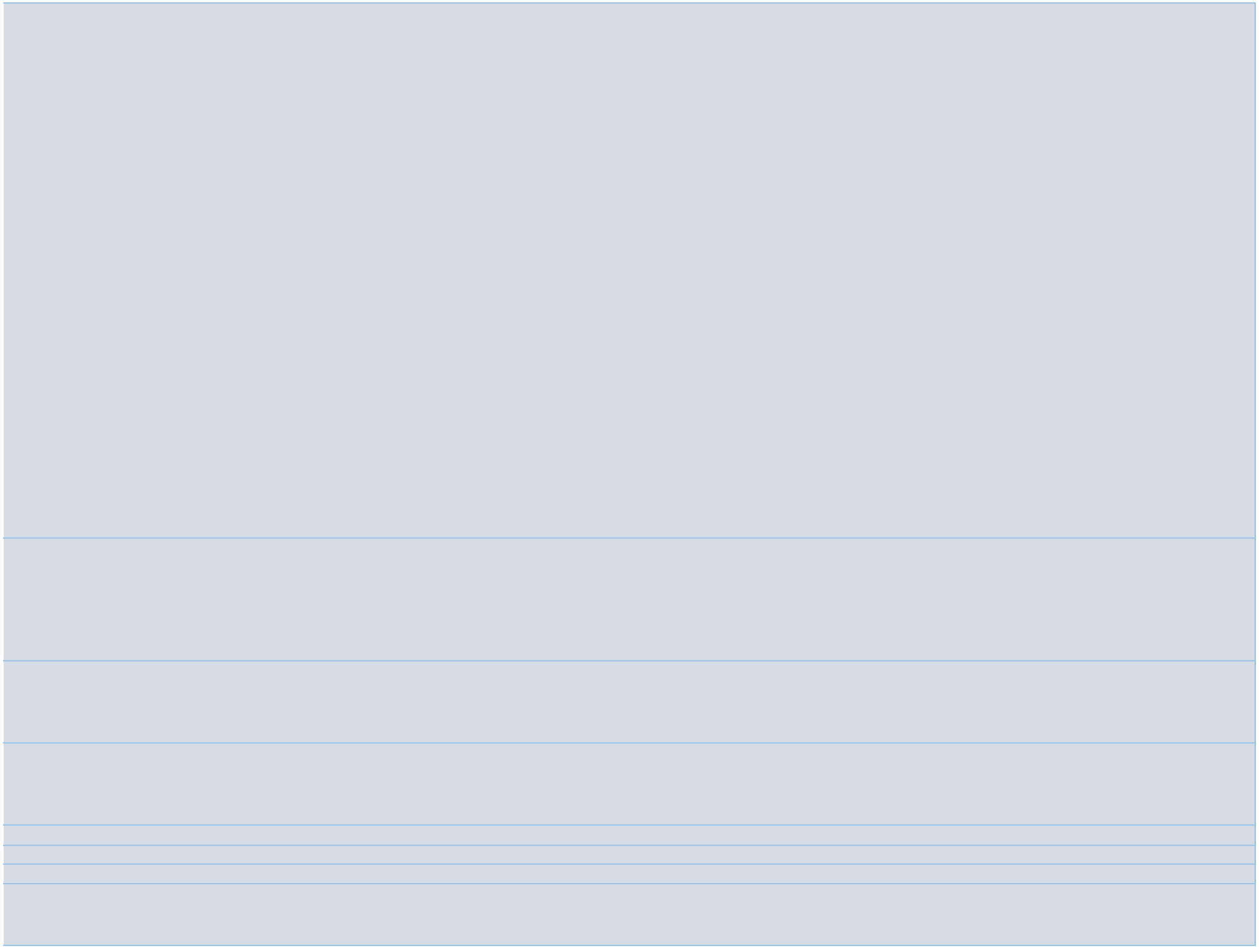
tion port wiring in both an enclosure or a switchboard.



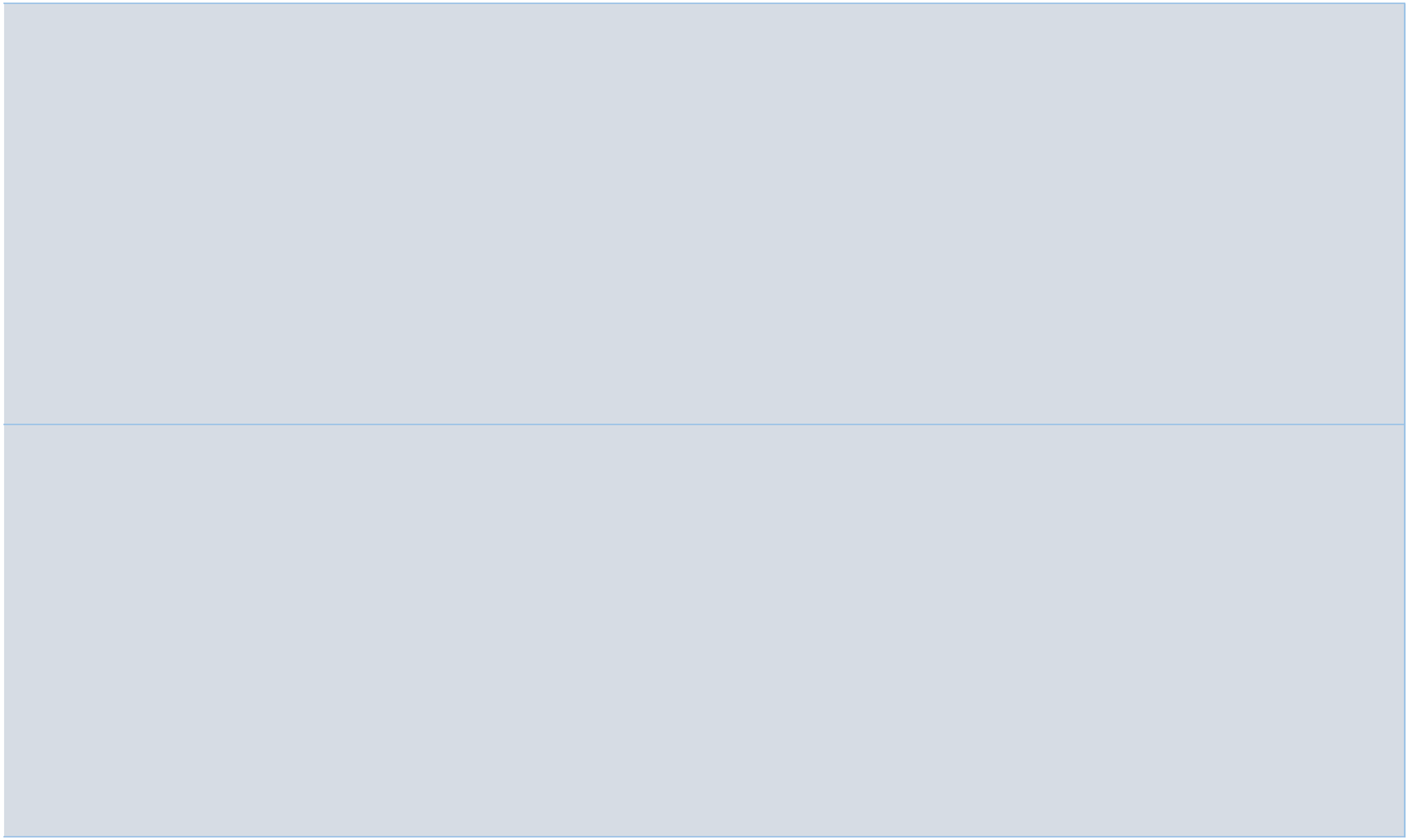
It also describes the accessories needed for mounting, as well as how to remove each component.

roller dimensions. To mount the controller:





d 7 mm (0.275 in.). When mounted, the controller mounting feet may extend beyond the controller dimensions by 8 mm (0.3 in.) in both directions. To mount the controller and the expansion module on a mounting



0.3 in.) in both directions. To mount the controller on Telequick:

ns are given in both millimeters and inches and apply to all LTMR and LTME models.

ol and power with 50 cm (1.64 ft) space or use separation plate. To limit the induced voltage in AC, it is possible to add a clamping resistor in parallel of the interposing relay.

ut time. Moreover, the more the voltage is high the more the phenomenon is important.

*TMR Motor Management Controller User Guide* . DOCA0128EN-02

ed to the RJ45 port on the LTMR controller, or to the HMI interface port (RJ45) on the LTME expansion module.

dule and the LTMCU:

ice or SoMove with the TeSys T DTM.

| |
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of the acceptable sounds and their causes.

nd then the relays will adjust to the input line. To adjust for multiple switching, you can go to the menu, "UPS Setup", on the front LCD display of the Matrix-UPS Electronics Unit (EU, the top half of th

of 10 kHZ to 150 kHZ, and 80% at 1 kHZ at 10 V/m over a frequency of 150 kHZ to 1 GHZ for both vertical and horizontal polarization. The Matrix-UPS meets the FCC Part 15 Class A computing devi

load, the UPS will shutdown within 4 seconds.

red default 208 VAC the letter "M" will be displayed, and the input voltage should be 208 VAC. If the letter "I" is displayed, the unit should be wired 240 VAC and the Input Voltage Select tap wire has

ıould not exceed 80% of the rated service, at nominal voltage. This limits the maximum current that the UPS can draw from a 30 Amp utility outlet to 24 Amps.

m of 4992 VA, and after accounting for the losses (< 7%), the UPS can only supply 4700 VA to the load in order to stay within the 24 Amps limit from the utility outlet.

urer.

while due to filtering action.

e load from the battery, which happens in about 50 microseconds. During this brief time, the filter has isolated the load from any disturbance, giving the detector time to operate.
the load. This is necessary so that the UPS does not feed any power back into the downed utility line, and prevents the utility line from loading the inverter if the utility line is a low impedance state.
**lure, but is controlled at that time** so that power is flowing into the battery (battery charging). This means that no transfer or other switches are necessary to connect the inverter to the load when the power fails.

and ready and the isolation filter in the UPS delays the power problem from reaching the output long enough to allow the inverter to reverse power flow and disconnect the input fault.

at different times, the FerrUPS risks dropping the load, while the Matrix-UPS will maintain stability. Efficiency with FerrUPS: At full load, the FerrUPS runs at 80% efficiency, compared to the 93% ef

of a Hertz. Since this is a tuned circuit at 60 Hz, minor variations in source power frequency may cause the transformer's magnetic field to collapse. This is very important when on-site generation of pow

o rear of the Matrix-UPS "J" IU and can be adjusted by using a flat blade screwdriver. The output receptacles on the Matrix-UPS "J" IU are similar to that of the domestic Matrix-UPS, with the addition of an L11-30R twi

across the Matrix-UPS product line.

rix-UPS hardwire kit.

ors:

own neutral and therefore all computers plugged into a Matrix-UPS do not contribute to the neutral current heating problem in anyway.
heating effects by about 36%.

s that the output power wiring does not touch or connect to the input wiring. All personal computers already have galvanic isolation between the input power and the computer logic built. This is a requir

terize the situation even if at first they seem to have nothing to do with the reported problem. Compiling enough information around a problem will often help paint a picture of what is wrong when you

aps of the Matrix-UPS are changing or if the batteries are being charged. Using the information should help to quickly isolate which of the modules are having the problem.

s unimportant. Just as the plumbing in a large stadium or a high-rise building is designed for scale, purpose, redundancy, protection from tampering or denial of operation, and the capacity to handle peak

bps Ethernet, you should deploy a network that is ready to support the demand without requiring an upgrade of the existing copper Ethernet wiring plant. You accommodate these latest demands by deplo
ver over Ethernet up to 90W per port, offered with Cisco Universal Power Over Ethernet Plus, and the access layer should also provide PoE perpetual power during switch upgrade and reboot events. The
uch as NetFlow.
in order to enable the scale and expanded uses and policies for the network driven by these trends.
) Gbps capacities or more over time.

ns—Cisco Digital Network Architecture Center (Cisco DNA Center) automates this network device configuration and management to achieve your organization's intent.

is the network that supports devices people use within a location to connect to information. The use of the word campus does not imply any specific geographic size or organizational boundary—the cam

uilding complex with high-density wired port and wireless requirements. The deployment may require very high availability for the services offered by the network, with a low tolerance for risk, or there
ess layers to the distribution layers. If devices connecting to the access layer have a requirement to communicate with a Layer 2 logical adjacency and those connections cover multiple physical wiring cl
s, while enhancing overall network performance. Such alternatives include the simplified distribution layer using options such as a switch stack or a StackWise Virtual system, and the simplified access
tivity across an access-to-aggregation boundary or have other means of implementing this functionality, such as when using fabric technology for campus designs—an integral part of Cisco SD-Access.
ditional multilayer campus design previously mentioned is a widely deployed, valid design choice, the design is not one that is typically recommended considering better alternatives that are currently ava
nfrastructure. This is especially evident for larger networks, because increasing capacity with dedicated devices becomes a requirement. Smaller networks, such as those at small remote sites, offer opport
.

terconnecting a group of LANs that are spread over a local geographic area. Campus network design concepts include small networks that use a single LAN switch, up to very large networks with thousa

s the network design and therefore the deployment and management of the network.

as improve resiliency.

s. For example, a site that occupies a single building might only require the access and distribution layers, while a campus of multiple buildings will most likely require all three layers.

tures and services that ensure security and resiliency for the entire network.

ndwidth traffic when users perform routine tasks, such as sending large emails or opening a file from an internal web page.
ing benefits for performance, management, and security.
ices, the access layer must help protect the network from human error and from malicious attacks. This protection includes ensuring that users have access only to authorized services, preventing end-use
s using advanced technologies, to ensure that traffic from these devices is not impaired by traffic from other devices and to ensure efficient delivery of traffic that is needed by many devices in the netwo

'i 6) APs, are driving the requirement for mGig port speeds (2.5 Gbps and 5 Gbps) at the access layer.  The higher MIMO rates of these APs, along with the rapid adoption of IoT devices is also driving th

can be more challenging than traditional switches with only 1 Gbps ports.  You need to take into consideration the number of access ports on the switch which support mGig, since not all switches suppo
ops uplinks.  This configuration would provide up to 20 Gbps uplink bandwidth, assuming all uplinks are active – as in a Multichassis EtherChannel (MEC) configuration.

: 20 Gbps or 7.8:1, assuming all mGig ports were operating at 10 Gbps.

20 Gbps, or 3.6:1.
pand capacity in a switch stack configuration

ch within the stack.

e only four 10 Gbps uplinks spread across two switches in the stack.  This configuration would provide up to 40 Gbps uplink bandwidth in a MEC configuration, when both switches are operational.  Ho
0 or 15.6:1 assuming all mGig ports were operating at 10 Gbps and all the 1 Gbps ports were being used.

Gbps : 40 Gbps, or 7.2:1.

› 10 Gbps speeds, and as you add additional switches in the switch stack.
ces (operating at mGig speeds and at 1 Gbps speeds) across all switches to maintain a similar oversubscription ratio.  For example, APs operating at 5 Gbps should be spread equally across the switches i
e switch of the stack fails, you don't have a double failure – meaning that you lose both the active switch and half of your uplinks.

he port density requirements of your floor IDFs (wiring closets).
sufficient power supplies are already provisioned within the chassis) exists within the IDF which houses the modular switch.  Adding an additional linecard may also be less expensive than purchasing an
antage of modular platforms over time, compared to stackable platforms.  Redundant supervisors can be deployed to provide chassis-level high availability such as Non-Stop Forwarding (NSF) and State
-user devices should be spread across available linecards to minimize the impact of the failure a single linecard within a modular chassis.

e, as you continue to add more linecards to a modular switch platform, you must keep in mind the distribution of the uplinks across the linecards, and the oversubscription ratio during linecard failure sce
onfiguration is eight, resulting in a maximum uplink bandwidth of 80 Gbps.  Further, this requires eight 10 Gbps switch ports across the distribution layer switches, for each access layer switch or switch

o of the switches within the stack.

pair, and fewer optical fiber pairs are needed between the distribution layer StackWise Virtual pair and each of the access layer switch stacks.  However, when deciding to upgrade the uplink speeds betw
ribution cabling – multimode fiber (MMF) or single mode fiber (SMF).
n be upgraded to 25 Gbps while the access layer still operates at 10 Gbps, and the access layer switches can be upgraded over a period of time.
u have building distribution cabling consisting of multimode fiber (OM2, OM3, or OM4), you have to determine if the cabling will support the distances between the main IDF (which may house the dist
s link lengths of 82m over OM2 at 10G, and up to 70m over OM2 at 25G. This module requires RS-FEC on the host port for full reach operation at 25G. Using BASE-R FEC the module can support 70/

ribution layer switches, and 4:1 between the distribution layer and core switches have been implemented in networks. The higher the oversubscription ratio, the higher the probability that temporary or tra
depends on the model of the Catalyst 9000 Series switch platform (specifically the version of the UADP ASIC and the number of UADP ASICS within the switch platform).  During periods of temporar
ority traffic which is more susceptible to packet loss – such as voice traffic – is given preferential treatment over lower priority traffic.  This preserves the quality of experience for your business critical a

ess extension deployments these access devices may be extended node switches. For MDU deployments the devices may be small distributed access switches or gigabit passive optical network (GPON) c

WAN, the distribution layer facilitates this connectivity.
hes.
ources for devices elsewhere in the network. The distribution layer also increases network availability by containing failures to smaller domains.
nented using a pair of physically separate switches operating as one device (StackWise Virtual) or using a physical stack of switches operating as one device. Resiliency is provided by physically redunda

ilures or disruptions.

d WLAN controllers. Depending on the size of the LAN, these services and the interconnection to the WAN and Internet edge may reside on a distribution layer switch that also aggregates the LAN acce

s, and WLAN controllers grows, the ability to connect to a single distribution layer switch becomes hard to manage. When connecting at least three distributions together, using a core layer for distributio

in.

on.

ou can save potential costly fiber-optic runs between buildings by locating a distribution layer switch in each of those buildings. As networks grow beyond three distribution layers in a single location, or
and scalable design, you can collocate distribution layers for data center, WAN connectivity, or Internet edge services.
* 2 redundant links for N distributions, down from N * (N-1) / 2 redundant links, as shown in the following two figures.

p connectivity between them, which organizations must have in the modern business environment where connectivity to resources to conduct business is critical. Connectivity to and from the core is Laye

ain the desired oversubscription ratio.
ayer switches to the access layer switches or switch stacks, as well as the speeds at which the ports are operating.

g of four 48-port switches along with a 2 x 25 Gbps uplink module in two of the switches within the stack.  The total number of 25 Gbps ports required at the distribution layer switches is 4 uplinks x 2 I
ps between the distribution layer and core layer switches.  This would provide an oversubscription ratio of 800:80 or 10:1 between the distribution and core layers. Depending upon your business requirer

itch ports at every distribution layer and core layer switch.  More importantly, it would require additional fiber optic pairs between the distribution layer switches and the core layer switches.
:ween the centralized data center and each of the buildings.  This could be a very expensive proposition, as existing conduit space between the buildings may not be capable of supporting additional cablir

n buildings.
ps between the distribution and core layers.

e the full capabilities of the lead platforms are not required.

ion with a larger workplace and economic significance. To mitigate the concerns about unavailability of network resources, campus designs include additional resiliency options, such as redundant links,
Layer 3 domain that provides a path to the rest of the network. This boundary provides two key functions for the LAN. On the Layer 2 side, the distribution layer creates a boundary for spanning tree prot

result in either a loop-free or looped design.

air in order to reduce or eliminate topology loops that STP must block and that are a common point of failure in LANs. Restricting a VLAN to a single switch provides a loop-free design, but it does limi

ndby routing protocol (HSRP) and virtual router redundancy protocol (VRRP) are the most common gateway redundancy protocols, but they only allow hosts to send data out one of the access uplinks to

e bandwidth from the rest of the network and can cause slower network convergence. The inefficiencies and the increased potential for misconfiguration drive network engineers to look for more appealin

lternative solution to the Spanning Tree Protocol (STP).

emoves the Layer 2-to-Layer 3 boundary at the distribution layer, and makes each access switch the boundary between the Layer 2 access ports and outbound Layer 3 connectivity. The benefits of this des

tiple access closets, the access switches must have the capability to support the Layer 3 routing functionality, and differences in IP addressing and subnetting must be accommodated. Many organizations

e physical switches that act as a single logical switch, such as switch stack or Cisco StackWise Virtual Pair (SVP), or the less preferred single, highly-redundant physical switch. One advantage of this des
uplinks. This is a key characteristic of this design, and you can load-balance up to eight links if needed for additional bandwidth. At the same time, multiple links in an EtherChannel have better performa

mic channel protocol performs consistency checks for interfaces programmed to be in the channel and provides protection to the system from inconsistent configurations. Cisco Catalyst switches provide
ugle logical interface and resiliency is provided by the distribution layer switch or switches. Also, the network will converge faster now that it is not depending on spanning tree to unblock links when a fa
ides a more efficient operation for IP Multicast in the distribution layer because there is now a single logical designated router to forward IP Multicast packets to a given VLAN in the access layer.
es switches for physical or logical stacking is also the basis for enabling resiliency features such as stateful switchover (SSO), non-stop forwarding (NSF), and in-service software upgrades (ISSU).

ting an *overlay* network with the required Layer 2 connectivity. Benefits of Cisco SD-Access technology are the decoupling of the Layer 2/Layer 3 forwarding plane of the endpoint/user from the underla
entation) running on a physical network (underlay network) in order to create alternative topologies to connect devices.

ogy to support group-based micro segmentation policies. Beyond support for the wired LAN and unlike any alternative virtualization technology, Cisco SD-Access also inherently supports integration of

ilable.

AN. Recent standards body work has proposed an alternative means to support Ethernet VPN (EVPN) overlays in the campus and, like Cisco SD-Access, has the option to use VXLAN encapsulation.

der forwarding table scale, due to the nature of the Multiprotocol BGP (MP-BGP) control plane.

AN can be a viable alternative to traditional campus virtualization options.

g them to lose connectivity. Also, Rogue DHCP servers can be used to issue malicious DNS servers. Users then looking to go to real websites will be sent to fake copies of these sites to steal credentials

untrusted hosts with leased IP addresses, MAC Address, switchport, and VLAN. Traffic being sent from these untrusted hosts will be filtered of any DHCP server messages, blocking any attempt of a ma

cache. This means traffic destined for the legitimate device will instead be sent to the attacker. The attacker can then forward the traffic to its intended destination making it look as if the traffic was neve

where the IP to MAC address binding is not valid.

logy change and possibly blocking traffic from a wanted path.

P addresses before a connection is established. It learns of these current and future threats through a growing database built on machine learning and Internet activity patterns. This means Cisco Umbrella
s attempted to be accessed by users.

h availability in the LAN must also consider the entire lifecycle of the deployment, including the need for updates and upgrades on the network.  This section discusses high availability features specific t

e and standby switches in a switch stack.  SSO allows the standby supervisor / switch to immediately take over in sub-second time if the active supervisor / switch fails.

StackWise Virtual pair, or the failure of the active switch of a switch stack.  When the supervisor or switch switches over from  the active to the hot-standby, it will continue switching IP data traffic flow

ry supervisor is active and is responsible for normal system operation. The secondary supervisor serves as a standby, monitoring the operation of the primary.  Information is synchronized between super
supervisor engine does not support uplinks on the module itself.  For link-level resiliency on the Catalyst 9600 Series, spread uplinks ports across the switch linecards.

ne, StackWise Virtual enables the creation of a loop-free topology.  Spanning-tree treats the StackWise Virtual pair as one bridge node, instead of two.  StackWise Virtual technology uses SSO / NSF to p

k – the StackWise Virtual link (SVL) – is used to transfer both data and control traffic between the peer switches.  The SVL is formed as an EtherChannel interface of up to eight physical port members.

ctor, switching capacity, port density, and redundancy, as well as providing a distributed data plane with a single control and management plane.
appear as a single virtual switch, the IOS daemon (IOSd) process on the active switch of the stack centrally manages all management plane and network control plane operations with Layer 2 and Layer 3
echanism, boosts data plane switching performance in the stack-ring switching architecture.

dels with the support of up to 160 Gbps stack bandwidth.  StackWise-80 is supported on Catalyst 9200L switch models with the support of up to 80 Gbps stack bandwidth.

odels with the support of up to 480 Gbps stack bandwidth.  StackWise-360 is supported on Catalyst 9300L switch models with the support of up to 360 Gbps stack bandwidth.

s in the channel fail.  Up to eight Ethernet ports can be combined into a single logical channel.  Multichassis EtherChannel (MEC) and cross-stack EtherChannel extend traditional EtherChannel by allow

led SMU has on the corresponding system. SMUs might not have an impact on traffic, or might result in device restart, reload, or switchover.  Hot patching enables SMU to take effect after activation wi

hen performing a software upgrade. The images are upgraded in install mode wherein each package is upgraded individually.  ISSU is supported in Catalyst 9000 Series standalone and modular platforms
l1.x is not supported.  On Cisco Catalyst 9500 Series Switches - High Performance, ISSU with Cisco StackWise Virtual is supported starting from Cisco IOS XE Gibraltar 16.12.1. Therefore, ISSU upgr

omplete. GIR allows the network administrator to easily manipulate the routing and first-hop gateway metrics of a network device that is about to undergo maintenance to make it a very unattractive path.

ade (FSU) feature significantly reduces the traffic downtime during a software upgrade. The fast software upgrade feature is supported on both stacking and standalone systems from IOS XE 16.8.1a and
rray (FPGA) upgrade is required.  Fast software upgrade is not supported if the switch is configured as StackWise Virtual System.
on the switch configuration.  Extended Fast Software Upgrade uses graceful restart capability (a feature of Cisco NSF) to ensure that device configurations, such as certain routing protocols, remain una

rganizations are more dependent on wireless networks than ever before. Increasing numbers of devices connect to the network every year, ranging from high-performance client devices to low-bandwidt
n Cisco Digital Network Architecture (Cisco DNA), our wireless solutions go beyond the latest Wi-Fi 6 (802.11ax) standard and are ready for the growing user expectations, IoT devices and next gen clo

ed Wireless Controller on Cisco Catalyst 9100 Series APs, for Cisco Catalyst controller features without a dedicated appliance.

ney.

lescribed later, with 1:1 active standby and N+1 redundancy keeps the network, services, and clients always on, even in unplanned events.

nes with built-in security: secure boot, runtime defenses, image signing, integrity verification, and hardware authenticity.

netry that provide an easy way to automate day-0 to day-N network operations, and deep insights into the health of your network and clients.  When paired with Cisco DNA, your network works for you.

o support business-critical wireless applications. From voice and data services to location tracking, Cisco WLAN controllers provide the control, scalability, security, and reliability that network manager

orms.

tal access point licenses only when you need them.

s they scale up and simplify the management of dynamically changing business and IT requirements.  The configuration model maps APs to three types of tags - policy tags, site tags, and RF tags.

a set of attributes that are applied to the wireless clients associated to the APs or to the APs themselves.  Profiles are reusable entities that can be used across tags.

y assigning tags. Policy tags are associated with a WLAN profile and a policy profile—each with their respective attributes shown in the figure below.

and a Flex Profile - each with their respective attributes shown in the figure below.

ıd line interface (CLI).

devices. Key benefits of the Cisco Catalyst 9100 Series APs include the following:

th Intelligent Capture, which provides Cisco DNA Center with deep analysis.

nergy consumption and more stringent security.

Catalyst switches and Cisco Multigigabit Technology, you can use your Category 5e or 6 cables to achieve speeds up to 10 Gbps.

lt right into the access point.

). Wi-Fi 6 communicates in parallel with devices, whereas existing standards communicated only "one at a time".
and IoT devices can last longer, which makes it the ideal standard.

authenticated traffic, robust password protection against brute-force dictionary attacks, and superior data reliability for sensitive information with 192-bit encryption.
h as 25 percent, as well as Flexible Radio Assignment (FRA), CleanAir, wireless intrusion prevention system (WIPS) and DFS detection. This silicon-level intelligence creates a self-healing, self-optimi

ocation data APIs. This cloud-based platform, which is compatible across Cisco Aironet, Cisco Catalyst and Cisco Meraki wireless APs, lets your enterprise see activity at its properties, act on these insi

rt 2003 from the access point and use it for location calculations.

uration and troubleshooting, and roaming at scale. In a centralized design model, the WLAN controller and APs are both located within the same site.
by using the control and provisioning of wireless APs (CAPWAP) protocol between the controller and the AP. This has the advantage of decoupling the subnet on which the wireless clients terminate fr

dinated fashion.

ploy the Cisco 9800-L WLAN controller as a local controller within the site.  The Cisco Catalyst 9800-CL virtual form factor deployed within a private cloud is another alternative and includes the same

nabling organizations to configure and control remote-site APs from the headquarters through the WAN, without deploying a controller in each remote site.
ll CAPWAP communication between the AP and the controller. This mode of operation is referred to as Cisco FlexConnect local switching and is the mode of operation described in this guide.

lexConnect.
t local switching and local mode. In this guide, the WLAN controllers that support both are the Cisco Catalyst 9800-80, 9800-40, 9800-L Series appliances and the Cisco Catalyst 9800-CL for private clo

d in either a private cloud or public cloud is an alternative to an appliance, since wireless traffic is typically locally terminated in a Cisco FlexConnect deployment. The Cisco Catalyst 9800-CL deployed
d with a primary, secondary, and even a tertiary WLC, as desired.  If connectivity to the primary WLC fails (the CAPWAP tunnel goes down), the AP establishes connectivity to the secondary WLC – po

t organizations can have a common policy and unified experience across both wired and wireless. In this model, the fabric WLCs communicate wireless client information to the fabric control plane, and
ning of wireless traffic through the wireless controller, and retains the ability to easily stretch the Layer-2 domain.

for small wireless deployments, since a separate on-premise controller does not need to be deployed.

: 9115AX and 9117AX Series running EWC.

'NCd instances varies from platform to platform.

lied to the AP.  If the default site tag is used, APs are load balanced across the WNCd instances in a round robin fashion.

NCd instances.  Therefore, a best practice design recommendation is to configure custom site tags, and not use the default site tag. For best performance, use a custom site tag to group APs within a roam

Group in classic Cisco AireOS wireless controllers.

e corporate wireless network, and the expectation of zero downtime is becoming the norm. The negative impacts of wireless network outages are just as impactful as outages of the wired network. Imple
dates (SMUs) for wireless controller fixes and updates, AP service packs (APSPs) for AP fixes and updates, and AP device packs for support for new AP models

ption for providing high availability. Cisco wireless deployments can improve the availability of the wireless network with controller recovery times in the sub-second range during a WLAN controller d

ong with the Cisco FlexConnect architecture in order to provide high availability across data centers for remote branches.  You can use a single backup WLAN controller in order to provide backup for m
an be deployed in different datacenters across the WAN link.
n configure APs with a priority using N+1 HA.  APs with high priority on the primary controller always connect first to the backup controller, even if they must push out low priority APs. When a primar

hysical port.  In a centralized design, wireless traffic is backhauled across the network infrastructure and terminated on the physical ports.  With the use of a single physical port per WLAN, the throughp
. If at least one controller port is functioning, the wireless controller continues to operate, APs remain connected to the network, and wireless clients continue to send and receive data.

sco StackWise Virtual configuration, for additional redundancy. When configured across switches the group is referred to as a Multichassis EtherChannel (MEC). The EtherChannel is configured using 8
witch stack.

k between the Cisco Catalyst switches in the Cisco StackWise Virtual pair during normal (non-failure) operation, because both the active and standby WLCs have ports connected to both switches.  This

vitches in a Cisco StackWise Virtual pair, switch stack, or separate line cards in a highly redundant modular chassis.

pes of SMUs - hot patching and cold patching.
oth the active and standby controllers.
eload.  When this happens, a switchover occurs, and the standby controller becomes the new active controller. The new active controller takes over all AP and client sessions. Then, the new standby cont

(RRM)-based AP neighbor information.  Based upon a chosen percentage per iteration (5%, 15% or 25%, with the default being 15%) the wireless controller auto-selects candidate APs to be upgraded i

work without having to upgrade the wireless controller software version.  Also, since the APDPs are hot patches, they do not require a reload and require no downtime of the wireless controller.

sers are accustomed on a wired network is available wirelessly. Multicast is required in order to enable the efficient delivery of certain one-to-many applications, such as video and push-to-talk group co
at have wireless users subscribing to a particular multicast group. In this guide, multicast-multicast mode is supported by using the Cisco Catalyst 9800 Series WLAN Controllers.
traffic. When combined with APs in Cisco FlexConnect mode using local switching, subscribers to multicast streams are serviced directly over the WAN or LAN network with no additional overhead be

ess access are supported, depending on the deployment.

all restricts access from the guest network (specific ports on the firewall need to be opened for the tunneled data connection). The guest network is only able to reach the Internet and the internal DHCP a

ith the additional option of encrypting the CAPWAP data traffic between the foreign and anchor wireless controllers.

of the guest traffic between the fabric border and DMZ using VRF Lite or similar techniques.  This type of deployment does not require any dedicated guest anchor controller to be deployed.  Alternative

/LAN within the branch which provides direct Internet access (DIA).

acceptable use policy (AUP) or end-user agreement (EUA) before accessing the Internet.  Since the organization's IT department typically has no control over the hardware or software capabilities of gue

he guest's credentials are then checked against the local database within the guest wireless controller.  The advantage of this option is that the entire management of guest wireless access is confined to th

re then checked against an external database within an authentication, authorization, and accounting (AAA) server.  Cisco Identity Services Engine (ISE) can provide both the external web portal and AA

llecting some information from customers who visit the site.  With this method, guests can use the wireless network and access the Internet from the venue by logging in using their existing social media

for home network use and uses multicast domain name services (mDNS) via link-local multicasting to share network services. Although this approach works well in home networks, a limitation of link-l

Catalyst switches and the cisco DNA Service for Bonjour on Cisco DNA Center. The Bonjour Gateway feature for WLCs solves the Layer 2 domain limitation for Bonjour by allowing the WLC to snoo

esign. Furthermore, routers cannot even use multicast routing to redirect the mDNS queries, because the time-to-live (TTL) of these packets is set to the value 1.

o Bonjour queries.

Cisco Catalyst 9800 Series WLCs, Bonjour service policies are applied to Policy Profiles (which include the VLAN to which the WLAN is terminated).  Policy Profiles and WLAN Profiles (which inclu

re mDNS is allowed or used. This will be the source IP address of those mDNS packets that are coming out from the controller acting as mDNS Gateway.

9200, 9300, and 9400 Series— is available on WLC platforms, including the Cisco Catalyst 9800 Series WLCs.
application-based QoS solutions end-to-end.

on Cisco IOS–XE based platforms, NBAR2 is a deep-packet inspection technology that includes support of stateful L4-L7 classification.

anning, and compliance purposes.
al technology for application management because it is no longer a straightforward matter of configuring an access list based on the TCP or UDP port number(s) to positively identify an application. In fa
age this classification result.

ssifies applications for the configured WLAN. Custom applications are also supported.  You can view Application Visibility on the WLC at an overall network level, per WLAN or per client.
d to a traffic-class and provides the following actions to be taken on each traffic-class: mark (with DSCP), police (to a rate), or drop.

pplications in order to prioritize, de-prioritize, or drop specific application traffic.
n for infrastructure upgrades.

es also assist in filtering rogue devices into specific categories based on the characteristics of a device.

tial threat level (informational, potential, or high) from within Cisco DNA Center.

capacity and reduce interference. TPCv1 is well suited for use in most deployments.

ossible to implement due to architectural restrictions or site restrictions—for example, when all APs must be mounted in a central hallway, placing the APs close together but requiring coverage out to the

RF profiles within RF tags. When used as a global configuration option, the settings apply to all APs attached to the specific controller.

coverage hole detection). For example, if you configure a minimum transmit power of 11 dBm, then no AP will transmit below 11 dBm, unless the AP is configured manually and no longer under contro

alogous to lanes on a highway—you only get the full benefit of the lane if it is completely separate from another lane on the same highway. If the lanes overlap each other (or worse, merge into a single l

is to track the available lanes (channels), which differ by regulations depending on the country of installation. Secondly, DCA assigns channels to APs that do not conflict with channels already assigned

environment) to converge to a steady state channel plan. After the startup mode is finished, DCA continues to run at the interval and sensitivity as specified by the organization.

ying APs for optimal 5 GHz coverage and density, you will likely have an unnecessarily high density of 2.4 GHz radios and their limited channel selection options, which will cause interference issues. C

ing of interface roles. Cisco FRA also provides a new metric, Coverage Overlap Factor, that admins can use to manually select and configure redundant radios within the deployment.

ount, percentage of failed packets, and number of failed packets. The alert indicates the existence of an area where clients are continually experiencing poor signal coverage without having a viable AP to

troubleshoot. RRM ensures that clients enjoy a seamless, trouble-free connection throughout the Cisco wireless network.

The properties and number of frequencies available for 2.4 GHz and 5 GHz devices differ significantly, with 5 GHz having as much as 8 times the available bandwidth as 2.4 GHz. Even so, the 2.4 GHz

GHz probes from a client and by immediately answering the client when the client uses 5 GHz probes. This system behavior encourages clients to use the available superior bandwidth in 5 GHz and incr

given channel and improves the throughput and apparent speed perceived by the client. However, to use these combined channels, an AP and a client must both support the capability.
multiple channels to create a single channel, larger slices of the spectrum are consumed, decreasing the overall number of non-interfering channels to use with DCA.  This can result in aggressive channel
amically balance the bandwidth selection for the types of clients and traffic that each AP uses.
eated by those devices.  For these reasons, you should run DCA in DBS mode.

are used for 802.11 Wi-Fi—Bluetooth headsets, microwave ovens, and many new IOT devices use different protocols but occupy the same frequencies required for operation of the WLAN.
would simply appear as noise to a Wi-Fi chipset.
of a CleanAir-capable AP regardless of the deployment requirements, and as a result, it monitors the range of 20 MHz-160 MHz channels.
r easy analysis and troubleshooting.

ersistent Interference Avoidance remembers this device and instructs DCA to pick channels for the affected APs that will not be interfered with by this periodic interference source.
an noise to the 802.11 chipset, all clients and APs typically wait for the channel to become less busy.  ED-RRM provides a safety net by doing two things:

o RRM through DCA, alerting DCA about interference disruptions related to the channel just abandoned.

entication of devices.  This is sometimes referred to as WPA Enterprise on wireless devices.  Most modern wireless devices support WPA2. You should consider migrating to the newer WPA3 standard
ication of Equals (SAE) to provide stronger protections for users against password guessing attempts by third parties. SAE employs a discrete logarithm cryptography to perform an efficient exchange in
igher grade security protocols for sensitive data networks.
between the APs and clients. The OWE extension uses the Diffie-Hellman algorithm cryptography to setup the wireless encryption. With OWE, the client and AP perform a Diffie-Hellman key exchang
olicy-based management and control for end-users accessing the wireless network.
eless device and the AAA server.  The EAP session is transported via RADIUS between the WLC and the AAA server.  Depending upon the capabilities of wireless device, the capabilities of the AAA s
ctory or data store such as Microsoft's Active Directory (AD).  This allows the network administrator to leverage existing AD credentials instead of duplicating them within the AAA server.  This can als
PMF is part of the IEEE 802.11 standard, which provides a level of cryptographic protection to robust management frames such as de-authentication and dissociation frames, preventing them from being
because the implementation of an AAA server is not cost-effective for the number of end-users who access the WLAN.  This may also be necessary in other environments if there is no end-user associate
guest WLANs are often implemented in order to minimize the complexity of onboarding a guest who needs only temporary wireless network connectivity.  Typically, the guest WLAN is terminated outsi

s control via the local user database in each infrastructure device, or via a centralized AAA server—such as Cisco ISE.
imited and that each administrator have a unique account.  A shared administrator account limits the ability to audit who accessed a particular network device and potentially made configuration changes.
erefore recommended that you control administrative access via an AAA server, which provides centralized policy-based management and control. It is recommended that you deploy redundant AAA ser
This can also be extended to provide RBAC for administrators through the use of AD groups.  The use of an external directory or data store can also provide a single point to grant or revoke credentials, n
nsuccessful attempts to access the device, before the account is disabled for a period of time, should also be enforced.  Successful and unsuccessful attempts should be logged either locally or to a central
agement interface of WLAN controllers on a separate VLAN (and therefore a separate IP subnet) from wireless client traffic.  In such a deployment, an access-control list (ACL) deployed on the Layer 3
e.  This protects the confidentiality of the information within the management session.  When using SNMP, it is recommended that you enable SNMPv3 where possible.  SNMPv2c relies on a shared com

practices into four broad categories: infrastructure, security, RF management, and Apple devices. The checklist is used to fine tune WLC configuration to match the best practices as suggested by Cisco.

network size.

ndreds in the medium design), with requirements for less than 25 APs. The preferred design strives to minimize cost with minimal numbers of components and features offered, though advanced and mis

tware feature capabilities are not as strong of a requirement, so options with the most economical preference are shown.

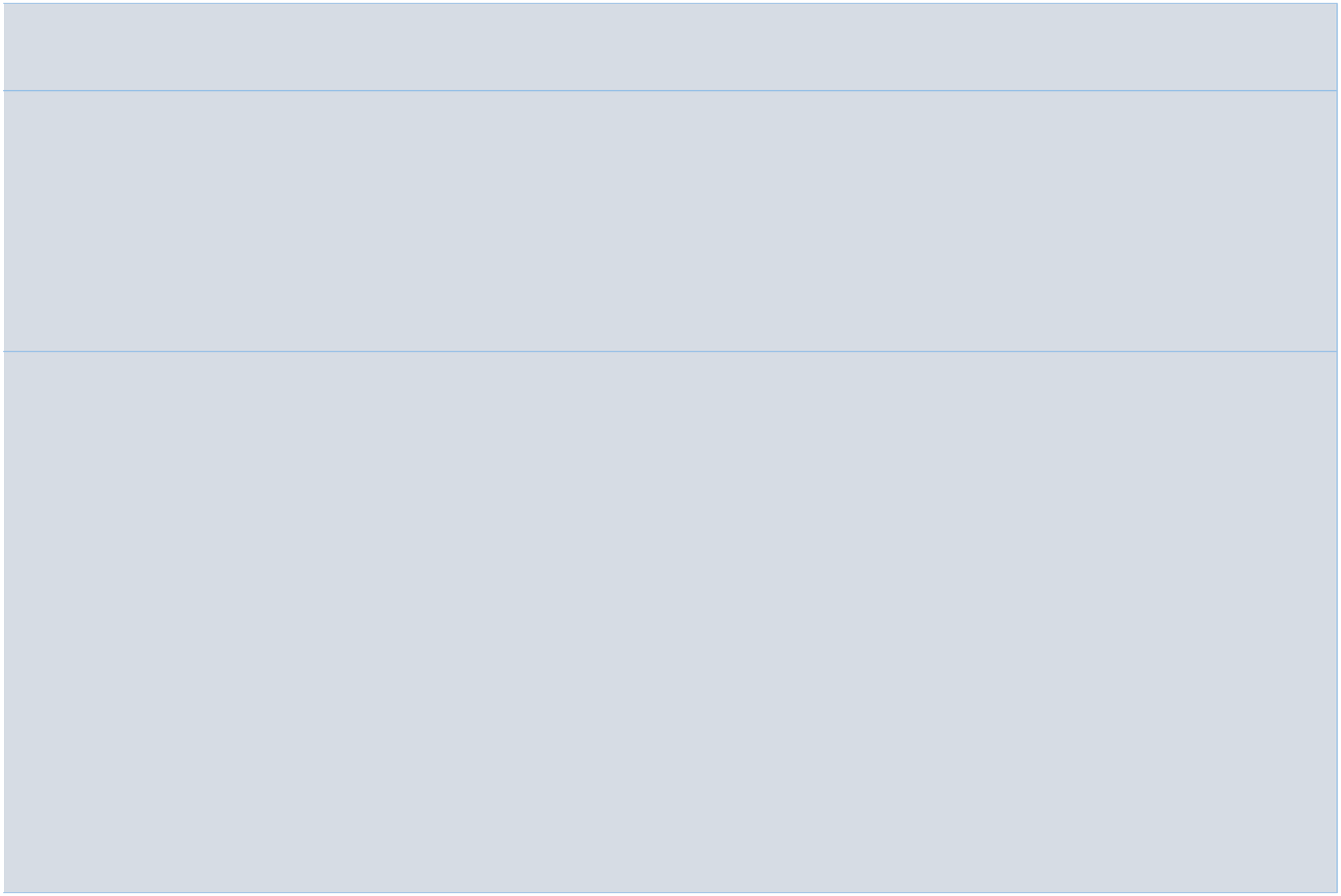
to WAN router at a remote site that has grown large enough to need an aggregation layer. The demands in the access layer for wired ports and WLAN devices typically number in the hundreds versus the

expand as an organization grows. Where densities and advanced software feature capabilities are not as strong of a requirement, options with a more economical and common sparing preference are shov

e densities may not be as high as supported; however, the requirements dictate needs for critical business continuity or advanced capabilities.

two core options in order to meet the core needs in the high-density large campus design. The flagship platforms for these options:

ıdant power and modular control plane, with the most advanced software feature capabilities.



ows for security policies that grant access privileges based on many different attributes and conditions in addition to a user's identity.

e centralized control of authentication, which allows the organization to quickly grant or revoke access for a user on any network device.

e device groups, which can function as a hierarchy based on attributes such as location, manufacturer, or role in the network. The combination of identity and device groups allows you to easily create aut

commands or limit helpdesk users to monitoring commands.

ement solution can enable and enhance the operational efficiency of network administrators.

ound REST APIs enables automation, integration, and innovation.

t from lower cost and reduced risk when deploying and maintaining their networks.

it aligns network management functionality with the way that network administrators do their jobs. Cisco Prime Infrastructure provides an intuitive, web-based GUI that can be accessed from anywhere fi

vices.

create a configuration task, providing device-specific values as needed. For other configuration needs, Cisco Prime Infrastructure enables you to define your own templates.

sts with the Cisco Technical Assistance Center.

tomize as needed.

to simplify the onboarding of APs to the network, The Software Image Management (SWIM) feature of Cisco DNA Center can simplify and standardize the deployment of wireless controller software in

nance Updates (SMUs) and rolling AP upgrades), as well as the increased efficiencies of 802.11ax (Wi-Fi 6):

DNA Center for assurance.  Cisco Prime Infrastructure can be used for advanced wireless configurations, and functionality currently not supported within Cisco DNA Center. Cisco DNA Assurance prov
available site layout by exporting the site hierarchy, devices, and Cisco DNA Spaces configuration from Cisco Prime Infrastructure to Cisco DNA Center.

r reporting, compliance, configuration, and for existing device support. Add Cisco DNA Center for assurance.  As Cisco DNA Center functionality develops to replace required functionality in Cisco Prim

e technology that answers this need.
experience. Another goal of campus QoS is to apply policies to at the edge to allow consistent treatment of traffic for a predictable user experience across the entire enterprise network.
ht prevent voice or video streams from being intelligible at the receiving side. Congestion is common when links are oversubscribed by aggregating traffic from several devices, and also when traffic on a
work to implement QoS across the entire network.

h traffic, and default classes).

ss-of-service assignment. Cisco DNA Center translates your QoS selections into proper device configurations and deploys the configurations to the devices. Additionally, use Cisco DNA Assurance to ga